Food and Agriculture Organization of the United Nations

United Republic of Tanzania

Forests for a sustainable future

EDUCATION MODULES FOR PRIMA RY SCHOOLS

Teacher's book

MODULE 3

FORESTS AND THE CLIMATE

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Forests for a sustainable future

EDUCATION MODULES FOR PRIMARY SCHOOLS

Teacher's book

MODULE 3
FORESTS AND THE CLIMATE

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Foreword

Teaching young people about protecting and sustainably managing forests is vital for our future.

Forests play important roles in our daily lives – they are a source of food, wood, medicines and energy for billions of people worldwide, and they host more than three-quarters of the world's terrestrial biodiversity. By sequestering carbon and influencing microclimates, forests help mitigate climate change; moreover, forests help communities adapt to climate change and increase their resilience to climate-related shocks.

The key to maintaining forests and their benefits over time is to manage them sustainably – this means ensuring that what is harvested in a forest is allowed to grow back and that the many values of forests are maintained over time. Today, however, people are increasingly disconnected from nature and lack awareness of forests and their benefits.

Forest education builds the knowledge, skills and shared values that underpin sustainable forestry and its contributions to sustainable development goals, such as those set out in the 2030 Agenda for Sustainable Development. In recent years, however, international forums have expressed concern that, in most countries, forest-related education is insufficient and outdated. The net result in a lack of awareness and understanding among people of all ages of the importance of forests.

Providing children with an understanding of the vital roles of forests is crucial for safeguarding natural resources for future generations. But the Global Assessment of Forest Education, published by the Food and Agriculture Organization of the United Nations (FAO) in 2022, reported that, in Africa, resources and learning materials for forest education in primary schools are absent or available to only a limited extent. The assessment also found that a lack of awareness-raising about nature in primary schools has contributed to a low level of interest in forest education.

It is essential that children in primary schools today learn about forests so they know why forests matter and how they can be used sustainably and thereby protected and maintained over time. Moreover, inspiring children from an early age about forests can help open new horizons and influence career pathways. When young people have a clear picture of forestry and the sector's role in solving sustainable development challenges, they are more likely to consider forestry as a viable career choice.

The education modules presented here are designed for children aged 9–12 in grades 3–5. They will increase the forest literacy of the children and, in the long term, enhance their capacity to make decisions in favour of sustainable forest use. The modules are inspired by the principles of the "education for sustainable development" (ESD) approach, which is based on learning methods that motivate and empower learners to make informed decisions, change their behaviour, and take responsible action for the benefit of the present and future generations. They use a more hands-on and interactive approach than standardized education methods.

The modules have been developed by the Ministry of Natural Resources and Tourism of the United Republic of Tanzania in the framework of the project, "Forests for a Sustainable Future: Educating Children", with technical contributions by FAO and the support of the German Federal Ministry for Food and Agriculture.

Nyabenyi Tito Tipo

FAO Representative in the
United Republic of Tanzania

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Introduction

The method: encouraging children to be problem solvers

The ESD approach emphasizes skills, abilities and values such as empathy, self-reflection, critical thinking, collaborative decision-making, and taking responsibility for present and future generations. This requires a shift towards active, participative and experiential learning methods that engage the learner and make a real difference to their understanding, thinking and ability to act. Using this approach, teachers help pupils develop their abilities to recognize, analyse and assess the sustainability of processes and practices. This should enable them to adopt sustainable practices in their own lives and to play an active part in sustainable development, locally and globally.

Through ESD activities, teachers motivate pupils to be open to different perspectives and new information. The ESD approach aims to develop the ability of pupils to solve problems and use fact-based knowledge in taking action. The box sets out key aspects of the ESD approach.

The "education for sustainable development" teaching approach

Teacher's role and approach

- The teacher acts as a partner for self-reflection.
- The teacher encourages pupils to come up with solutions rather than demanding answers.
- The teacher provides prompts and guidance rather than definitions.
- The teacher's instructions purposefully lack context to encourage a pupil's ability to infer it autonomously.
- The teacher trusts pupils' capabilities and skills and treats them with patience and understanding.

Pupils are encouraged to:

- be open to the world and to integrate new perspectives;
- think and act in a forward-looking manner;
- acquire knowledge and act in an interdisciplinary manner;
- learn how to deal with incomplete and overly complex information;
- approach decision-making processes in a cooperative manner;
- learn how to cope with dilemmas in decision-making situations;
- take part in collective decision-making processes;
- self-motivate to take action and spur others to do the same;
- reflect on their own principles and those of others;
- ground all decision-making and planning actions in the notion of equity;
- plan and act autonomously; and
- show empathy and solidarity towards people in need.

Pupils learn better when:

- The environment promotes their active participation and action-oriented learning.
- Learning takes place in a participatory way and involves everyone.
- They are encouraged to reflect on what has been learned and on the values and perspectives of everyone.
- The learning topics:
  - » take past experiences and cultural factors into account;
  - » are significant in the pupils' daily lives;
  - » directly affect and are interesting to the pupils;
  - » can be linked to existing knowledge; and
  - » are analysed in an interdisciplinary manner and from different perspectives.

The structure: how the learning is organized

To maximize the probability of successful learning outcomes, the forest education modules follow precise didactic criteria and have a distinctive structure.

The forest education material comprises three modules, each aimed at a specific primary-school grade level: Module 1 – Grade 3; Module 2 – Grade 4; and Module 3 – Grade 5.

The central themes of all three modules are the multiple functions of forests and the importance of their sustainable management. Each module also explores a specific theme, as follows:

- **Module 1: Forest products, plants and animals (biodiversity).** Pupils learn about animals and plants that live in forests.
- **Module 2: Forests, health and well-being.** Pupils learn about the benefits (also called ecosystem services) that forests offer people in their daily lives.
- **Module 3: Forests and the climate.** Pupils learn how climate and forests are related and why forest protection and sustainable use are important for the climate.

The modules consist of chapters, with each chapter containing three or four lessons of 40 minutes each. Each chapter follows the same pattern: a first lesson in which the teacher introduces a topic; one or two practical lessons in which the pupils explore the topic through games and activities; and a final lesson for reflection and discussion.

In total, the three modules contain 26 chapters. Each module has its own teacher's and pupils' books, as described below.

Teacher's books

Each teacher's book consists of chapters and a glossary. Each chapter contains an appendix that collates the various photographic images used in the chapter, which may be cut out and used in specific lessons as visual aids.

Each chapter has the same structure, as follows:

- An **overview** of the content, which summarizes the topic addressed in the chapter and the proposed activities.
- **Objectives**, which set out three or four key skills and learnings that the pupils will acquire from the chapter.
- **Background information** comprising three paragraphs to provide teachers with explanations of the topics addressed in the chapter, as well as photographs as visual aids. The background information does not necessarily reflect the flow of a chapter's activities. The latter follow a pedagogical logic and the former presents information sequentially, from simple to complex, to make the text more readable and understandable. Where applicable, the background information contains cross-references to relevant chapters in the same module; these connections enable the teachers to gain a deeper understanding of the contents and, if desired, to make pupils aware of related topics that will be covered later in the course. Although most of the information needed to perform the lessons is included in the activities, teachers are advised to read the background information before teaching the chapter to obtain a preliminary understanding of the topic and to enable them to better answer pupils' questions during the lessons.
- Three or four **lessons** designed to span 40 minutes each. The lessons comprise discussions, drawing, memory games, quizzes and other activities. Typically, the first lesson of a chapter introduces the topic to the

pupils and is designed to build their interest and motivation for the subject through exercises and activities. The activities in the second lesson (and third lesson, where applicable) aim to deepen competencies, and the last lesson encourages reflection and discussion. From this structure, pupils acquire and deepen their knowledge of the chapter's topic while also linking it to related themes. Each activity includes an indication of the time that should be allocated to it, as well as whether it should be performed indoors or outdoors.

- **Activities** present detailed instructions for teachers to follow when engaging with pupils. Where applicable, activities have lists of **required materials**, presented with simple illustrations. A section titled **preparation for the lesson** provides teachers with information on the preparation needed beforehand (although not all lessons require preparation). The expected duration and recommended setting (whether indoors or outdoors) are specified for each activity.

This icon indicates activities best conducted in the classroom.

This icon indicates activities best conducted in the schoolyard – for example, they may require more space for the pupils or are designed to enable pupils to interact with the natural environment.

- A section titled **preparation for the next lesson**. This is included at the end of most lessons and chapters to alert teachers to the need to prepare in advance for following lessons or to bring materials to school (or to ask pupils to do so). Teachers are strongly encouraged to read the instructions well in advance of lessons to ensure adequate preparation.

The teacher's books are colour-coded (yellow for Module 1, orange for Module 2 and green for Module 3), and icons are used to help teachers navigate information while teaching. Background information and preparatory instructions have a coloured background, and instructions for conducting the lessons have a white background.

Pupil's books

All lessons have been structured to be taught without the need of a pupil's book. However, to support children in following the lessons, a pupil's book has been developed for optional use.

The pupil's books are based on the corresponding teacher's books and are designed to serve as a reference for pupils, guide them through activities and help them follow the teacher's instructions.

The pupil's books contain instructions, photographs and drawings to support the pupils in carrying out activities. The children will not write in the pupils' books directly; rather, they will be prompted to write (or draw) in their exercise books where necessary.

Except for the background information, the pupil's books follow the same structure as the teacher's books, with icons helping pupils distinguish the type of activity that they are being asked to perform. For activities that require pupils to make drawings in their notebooks, simple, stylized examples are provided.

Chapter titles, by module

Module 1
Forest products, plants and animals (biodiversity) – Grade 3

In this module, pupils learn about the animals and plants that live in forests.

Chapter 1: Introduction to forests and their biodiversity
Chapter 2: What is a tree?
Chapter 3: Forests and soil
Chapter 4: Animals in the forest
Chapter 5: The life of bees in a colony
Chapter 6: Pollination and bee products
Chapter 7: Beekeeping
Chapter 8: Forest products
Chapter 9: Our forests in the United Republic of Tanzania

Module 2
Forests, health and well-being – Grade 4

In this module, pupils learn about the benefits that forests offer people in their daily lives.

Chapter 1: The benefits of forests
Chapter 2: Food from the forest
Chapter 3: Edible insects
Chapter 4: Hunting
Chapter 5: Forests and water
Chapter 6: Medicinal plants
Chapter 7: Wood products
Chapter 8: Wood processing
Chapter 9: Forests and livelihoods

Module 3
Forests and the climate – Grade 5

In this module, pupils learn how climate and forests interact and why forest protection and sustainable use are important for the climate.

Chapter 1: Weather, climate and forests
Chapter 2: The greenhouse effect and climate change
Chapter 3: Photosynthesis
Chapter 4: Wood and other sources of renewable energy
Chapter 5: Sustainable forest management
Chapter 6: Forest and beekeeping laws
Chapter 7: The work of a forester
Chapter 8: Forests and climate change – What we can do

CHAPTER 1

Weather, climate and forests

Overview

In this chapter, the pupils will learn about the origins of weather, the difference between weather and climate, and how forests influence climate. In an outdoor experiment, they will learn about the effects of trees on the local climate and recognize the positive effects of trees on their environment. The pupils will also find out why trees are important in villages, towns and cities, and create an informative poster on this topic.

Objectives

By the end of the chapter, the pupils will be able to:

- define the concepts of climate and weather, and explain the difference between the two;
- explain the relationship between forests and climate; and
- describe how trees affect local temperatures.

Background information

Are weather and climate the same?

Although they are often wrongly used as synonyms, climate and weather are not the same thing.

Weather is the set of day-to-day conditions in the atmosphere, including precipitation, temperature and wind. It can change daily.

- **Precipitation.** The heat of the sun over the sea and other water bodies causes water to evaporate and the vapour to rise, forming clouds. This moisture in the air eventually falls as precipitation in the form of rain or snow.
- **Temperature.** As the sun warms the Earth's surface, it heats the atmosphere, too. In some parts of the Earth – the equatorial regions – the sun shines almost directly down; in other parts, the sun's rays arrive at an angle, with the angle increasing with latitude. Much more energy arrives at the surface of the Earth when the sun shines directly down. This is the main reason why it is generally hotter at the equator than, for example, at the North and South poles.
- **Wind.** Even in the same landscape, the sun warms the Earth unevenly. For example, an area with a dark surface (such as a recently burnt field) will absorb more heat than a more reflective surface, such as a snow-covered field. Because the Earth warms unevenly, so too does the atmosphere. Warm air rises, creating areas of low pressure that cause cooler air to rush in. This rushing air is what we call the wind.

The climate is the average weather conditions recorded in a region over a long period (usually 30 years or more). In contrast to the weather, the climate does not change daily. A description of the climate includes information on, among other things, the average temperature in different seasons, the average monthly and annual rainfall, and the average daily, monthly and annual amount of sunshine.

How do forests and forest plants influence the weather and climate?

Forests and forest plants rely on the weather to obtain sufficient sunlight and moisture to grow.

Forests and forest plants, in turn, influence the weather. For example, forest transpiration contributes to the formation of clouds and is an important part of the water cycle. Clouds bring rain and snow, thereby releasing water back into the landscape, including forests. The larger the forest area, the more transpiration occurs, the more clouds are formed and the more rain is produced. Individual trees can transpire hundreds of litres of water per day (see Chapter 5).

Trees and forests make important contributions to the Earth's climate, both locally and globally, as follows:

- **Globally**, trees absorb carbon dioxide and store it as carbon in their wood. Carbon dioxide is one of the greenhouse gases that contribute to global warming by trapping heat in the atmosphere. The concentration of carbon dioxide (and other greenhouse gases) in the atmosphere is increasing worldwide, which is warming the planet and changing the climate. By capturing carbon dioxide and storing it in wood and forest soils, trees and forests can help reduce the extent of global warming.
- **Locally**, forests can help reduce heat. The leaves in tree canopies block the sun's rays and provide shade. In addition, trees absorb water from the soil through their roots and release it into the air through their leaves, branches and trunks in the form of vapour, cooling the environment. Trees also contribute through transpiration, which is vapour released from leaf pores (like perspiration from humans). This cooling effect of trees and forests is measurable in towns, villages and cities. If well positioned and managed, trees in cities can cool the air by 2–8 °C.[1]

In large forest areas such as the Congo Basin rainforest, the huge volume of water that the forest circulates can influence the climate, not just locally but across the region.

Picture 1.1. Shade under a forest canopy

Picture 1.2. Rainforest mist

How does the climate affect forests?

Forests are affected by the climate in many ways. Global warming, for example, may increase the prevalence of drought in some regions. The decreased moisture may stress trees and other vegetation, leading to increases in insect attack and fire, and jeopardizing forest health and sustainability.

Forest loss can have negative impacts on the climate. For example:

- When trees die, the carbon they store is released into the air as carbon dioxide and other greenhouse gases, contributing to global warming (see Chapter 2 and Chapter 3).
- When forests are removed, they are no longer able to absorb carbon dioxide from the air and their contributions to combating climate change are lost.

Picture 1.3. A river flowing in a forest

LESSON 1
What makes the weather?

1

1 Activity 1: Mimic the weather "waving"

outdoor This activity should take **10 minutes**.

1. In the schoolyard, explain the activity to the pupils. Read out a "weather report" and instruct the pupils to perform actions with their hands to illustrate the weather.
2. Ask the pupils to stand shoulder-to-shoulder in a circle around you.

> **Tip:** Practise a few actions (e.g. hand-waving) with the pupils before starting the activity.

3. Read the weather report (below) aloud and tell the pupils to carry out the corresponding actions.

Weather report

Early in the morning, the sun rises and warms us with its rays.
Wave to your fellow pupils on the other side of the circle.

A light breeze is coming.
Wave your hands gently in the air.

The breeze becomes stronger.
Wave your hands more firmly.

Clouds are gathering.
Stretch out your hands, facing upwards, and keep them steady above the ground.

The first raindrops fall.
Lightly pat one of your palms with the fingers of your other hand.

The rain becomes stronger.
Pat harder.

And even stronger.
Pat even harder.

The rain becomes a thunderstorm.
Clap your hands loudly.

The rain becomes softer again.
Pat your palm lightly with your fingers.

The wind blows gently.
Blow lightly on your hands.

And the sun comes out again.
Spread the fingers on both your hands and put them near your face to create a smiling sun.

2 Activity 2: Understand the day-to-day weather

indoor This activity should take **20 minutes**.

1. Ask the pupils to list the types of weather they experienced in the previous activity (rain, wind, sunshine, etc.).
2. Copy Figure 1.1 onto the board. As you draw, ask the pupils to think about what makes the weather.

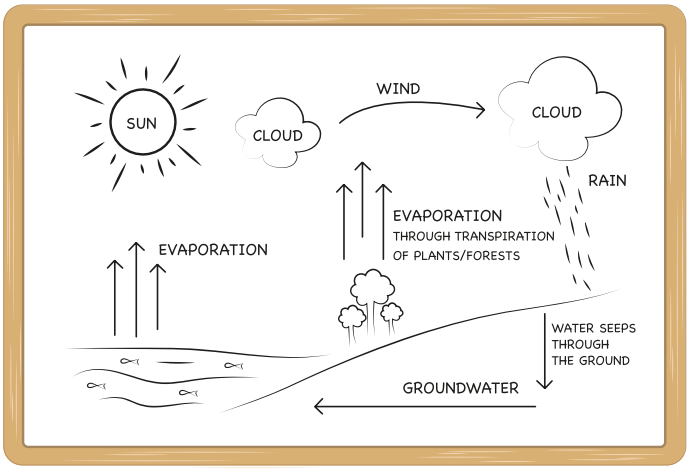


Figure 1.1. What makes the weather?

3. Invite one or two pupils to briefly present their ideas about the drawing and what makes weather.
4. Then, **explain**:
   - » The weather comprises sunshine, rain, wind and other things.
   - » The sun's heat causes water to evaporate from the sea, lakes and other water bodies, and moisture rises into the air.
   - » Water also evaporates from trees and other plants in forests when the sun shines. Trees also release water vapour through transpiration, which consists of water vapour released from the leaves.

- The evaporated water forms clouds in the sky. Later, the water in these clouds will fall back to the Earth as rain or snow.
- Wind is caused when warm air rises, leaving behind an area of lower pressure. Cooler air rushes into this low-pressure area, creating wind.

5. Ask the pupils to copy the drawing into their exercise books.

3 Activity 3: Discuss the weather and climate

indoor

This activity should take **10 minutes**.

1. Ask the pupils:
   - Are weather and climate the same?
2. Invite a few pupils to share their thoughts.
3. Write on the board: "Weather and climate are not the same!" (see Figure 1.2).
4. **Explain:**
   - Weather is the day-to-day state of the atmosphere in a place – such as the air temperature, the strength and direction of the wind, and the amount of precipitation (rain and snow) that falls. The atmosphere, also called the "air", is the layer of gas enveloping the Earth. It contains a mixture of gases, such as oxygen, carbon dioxide, methane and water vapour. The atmosphere is held in place by the Earth's gravity.
   - Climate is the average weather in an area or region, as recorded over a period of at least 30 years. In contrast to the weather, the climate does not change daily.
5. Write the definitions on the board, as shown in Figure 1.2. Ask the pupils to copy the Figure into their exercise books.

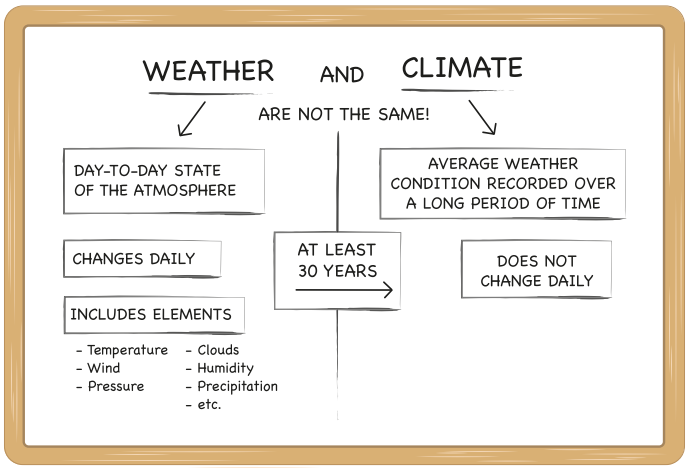


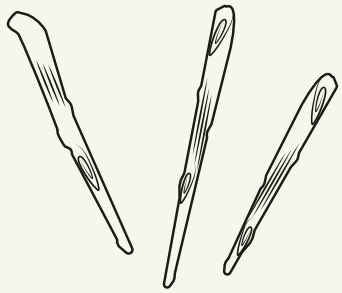
Figure 1.2. Weather versus climate

LESSON 2

How do forests, weather and climate interact?

2

Required materials



3 STICKS
(each 40–50 cm long)

Preparation for the lesson

- In the schoolyard, make a plus (+) sign on the ground using two sticks and a minus (-) sign using the other stick. Place them on the ground about 10 m (metres) apart.
- In the classroom, draw Figure 1.3 on the board. You will use this to explain the activity to the pupils.

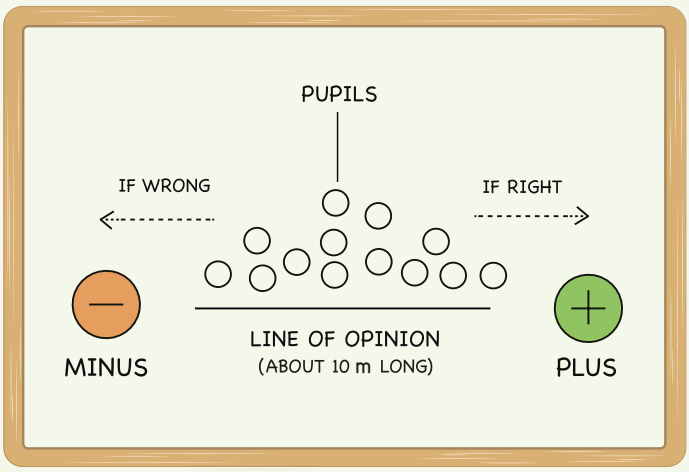


Figure 1.3. Line of opinion

1 Activity 1: Express your opinion on the link between forests and weather

outdoor This activity should take **30 minutes**.

1. Explain to the pupils that you will read out eight statements. They will need to decide whether each statement is right or wrong. They should keep their answers to themselves, for now.
2. Read out the eight statements (given below).
3. Explain that you will read the statements aloud again, one by one, but this time the pupils will need to form a "line of opinion".
4. Tell the pupils that they will form the line of opinion between the plus and minus signs marked on the ground in the schoolyard. Explain that:
   - » Those who think a statement is **right** will go to the **plus** sign.
   - » Those who think a statement is **wrong** will go to the **minus** sign.
5. After explaining the tasks, ask the pupils to form the line of opinion between the plus and minus signs that you previously laid out on the ground.
6. Read the first statement aloud.
7. Ask the pupils to go to the plus sign if they think the statement is right and the minus sign if they think it is wrong. If they cannot make up their minds, they should stand in the middle, between the two signs.
8. When all pupils have chosen their answers, reveal whether the statement is right or wrong. Explain the answer in more detail by referring to the background information at the start of the chapter.
9. Read the next statement and repeat steps 7 and 8.
10. Continue until you have completed the activity for all eight statements.

Statements:

» Trees provide shade when it's sunny.

Right. The treetops block some of the sun's rays, thus providing shade and helping cool the environment.

» The air is more humid in forests than outside them.

Right. Trees take up water from the soil through their roots and release it into the air through their leaves, branches and trunk in the form of vapour. Trees also contribute through transpiration, which is vapour released from leaf pores (like perspiration from humans). This makes the air more humid and also helps cool the environment.

» Rain and sunlight have no influence on trees.

Wrong. Trees need sunlight and water to survive and grow.

» A big tree transpires fewer than 20 litres of water on a hot day.

Wrong. A big tree can transpire hundreds of litres of water per day.

» Forests are very important for the Earth's climate.

Right. Trees absorb carbon dioxide, a greenhouse gas. The amount of carbon dioxide in the atmosphere is increasing, causing the Earth to become too warm. By removing carbon dioxide from the atmosphere and storing it in wood and soils, forests can help reduce this warming effect. When forests are cleared, however, the carbon stored in their wood and soils is released into the atmosphere, contributing to global warming.

» Forests in United Republic of Tanzania do not affect the global climate.

Wrong. Every forest contributes to the global climate by storing carbon and thus helping minimize global warming. The larger the forest area, the greater its influence on the climate.

2 Activity 2: Reflect on what you learned

This activity should take **10 minutes**.

1. In the schoolyard, ask the pupils to form a semicircle again.
2. Ask the pupils to reflect on what they have learned in this lesson. Which facts surprised them (in the sense that they would never have suspected it)?
3. Ask the pupils to put their statements into words. For example:

   "I have heard before that …"
   "I did not know about …"
   "I was surprised to learn that …"

4. Lead a discussion on how forests influence the climate, being sure to mention carbon storage, shade and transpiration.

LESSON 3

How can trees cool the environment?

3

1 Activity 1: Appreciate the cooling effect of trees

outdoor

This activity should take **15 minutes**.

1. Organize the class into two groups of equal size.
2. Tell one group to rest in the shade of a tree for 5 minutes.
3. Tell the other group to stand in the sun for 5 minutes.
4. After 5 minutes, tell the two groups to swap positions.
5. Ask the pupils to write in their exercise books how they feel as they stand under the tree and in the sun. They should also think of reasons for any differences and write these down, too.
6. After the allotted time, request the pupils to form a semicircle in front of you for the discussion.
7. Ask the pupils:
   - ► How did it feel in the sun? How did it feel in the shade of the tree? Did you notice a difference? Describe the difference. (Invite several pupils to answer.)
   - » **Answer:** It was much warmer in the sun than in the shade of the tree.
   - ► What is the reason for the difference? (Remind the pupils what they learned in the previous lesson.)
   - » **Answer:** The tree's leaves stop some of the sun's rays from reaching the ground, and the tree's transpiration also provides a cooling effect.
8. Conclude by telling the pupils that this cooling effect is important in villages, towns and cities – urban trees can cool the air by 2–8 °C.

2 Activity 2: Discuss how trees help cool the environment

outdoor

This activity should take **25 minutes**.

1. Ask the pupils to give examples of the positive effects of trees in towns and forests near towns. If necessary, add to their answers from the list below.

2. After about 10 minutes, **explain**:

   - The release of vapour from trees, their transpiration and the shade they cast, cool the environment.
   - Trees absorb carbon dioxide from the air and store it as carbon. Carbon dioxide is a greenhouse gas, meaning that it contributes to global warming. By removing carbon dioxide from the atmosphere and storing it, trees and forests can reduce global warming.
   - Trees and forests filter pollutants such as dust from the air and also produce oxygen, which people – and all animals – need to breathe. In this way, trees and forests provide clean and fresh air.
   - There are good reasons unrelated to climate to plant trees in towns. For example, trees provide habitat for wildlife, even in cities, and increase the well-being of people by reducing their stress, providing opportunities for recreation, supplying materials such as woodfuel, and generally improving the quality of life.

3. Ask the pupils to think about where trees and forests are located in their city, town or village (or near the school).
   - Where would they like to have more trees?
   - Why?
4. Ask some of the pupils to share their answers.

Preparation for the next lesson

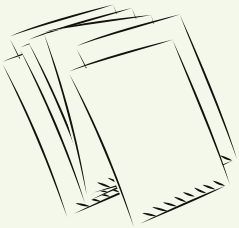
Ask the pupils to bring into class some pictures showing why trees are important in villages, towns, cities or communities. These might include, among others, images cut out of newspapers or photos that they have taken themselves. As another option, bring these items in yourself.

LESSON 4

Create a poster on why trees matter

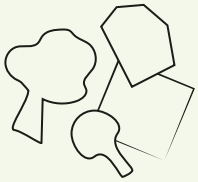
4

Required materials



SHEETS OF PAPER
(1 for each group of 6–7 pupils)

MARKER PENS
(1 for each group)



CUT-OUTS
(if any)

1 Activity 1: Create a poster on the importance of trees for people

This activity should take **40 minutes**.

1. Write on the board:
   - Why are trees important in a village, town, city or community?
2. Organize the class into groups of six or seven pupils.
3. Give each group a sheet of manila paper and at least one marker pen.
4. Tell each group to design a poster to explain why trees are important in their village, town, city or community. The poster must include the following:
   - Drawings (and pictures, if available) including trees.
   - Reasons why trees are important (written on the poster).
5. After about 30 minutes, ask the groups to show and briefly explain their posters to the class.
6. Hang the posters in the classroom for at least a few days so that the pupils can look at them in their own time.

Notes

[1] **Enete I. C, Alabi, M. & Chukwudelunzu, V.** 2012. Tree canopy cover variation effects on urban heat island in Enugu City, Nigeria. *Developing Country Studies*, 2(6): 12. www.iiste.org/Journals/index.php/DCS/article/view/2191/2203

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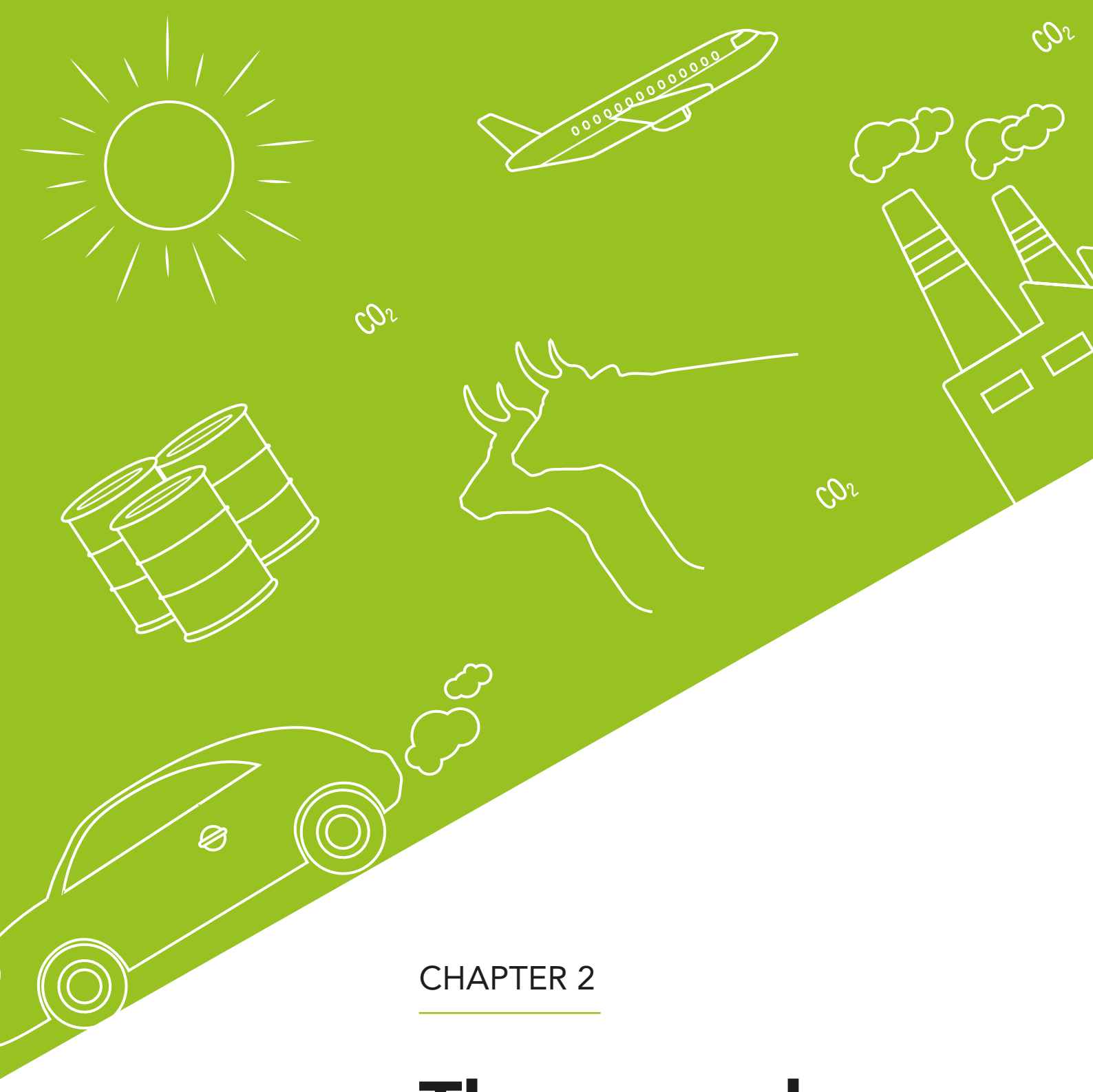

CHAPTER 2

The greenhouse effect and climate change

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Overview

In this chapter, the pupils will learn about the greenhouse effect and how it causes global warming and other climatic changes. They will learn the difference between the natural and human-induced greenhouse effect through discussion, and they will gain a deeper understanding through drawings and by playing an outdoor game. The pupils will examine several illustrations to help them understand how human actions can affect the climate and ultimately their immediate environments.

Objectives

By the end of the chapter, the pupils will be able to:

- describe the concepts of the greenhouse effect and climate change;
- explain the difference between the natural and human-induced greenhouse effect;
- explain the relationship between the human-induced greenhouse effect, climate change and forest degradation; and
- explain how climate change affects forests and people.

Background information

What is the greenhouse effect, and why is it important for life on Earth?

The greenhouse effect is the warming of the Earth that occurs when gases in the atmosphere trap heat from the sun that otherwise would be reflected back into space. It is a natural phenomenon that warms up the Earth sufficiently to support life. Without the greenhouse effect, the Earth would be 33 °C cooler.[1]

The Earth's warming process is similar to what happens in an artificial greenhouse. Greenhouses are buildings made of transparent materials such as glass that let in sunlight and trap heat, raising the temperature of the air inside. Greenhouses are commonly used in cool regions to grow plants that need additional warmth.

The atmosphere is a thin layer of gases enveloping the Earth, held in place by gravity. It works in a similar way to a greenhouse by trapping heat close to the planet's surface.

- During the day, the sun's rays pass through the atmosphere.
- Some of these rays are absorbed by the Earth's surface, but others are reflected, especially by light-coloured surfaces such as snow and clouds. The rays absorbed by the surface warm the planet, but not sufficiently to support life.
- Some of the heat in the reflected rays disappears into space, but some is absorbed by gases in the atmosphere and re-emitted in all directions, including back to Earth. These gases are called greenhouse gases.
- This reflection of heat by greenhouse gases makes the Earth warm enough to support human life and the rest of the planet's rich biodiversity.

Carbon dioxide is the main greenhouse gas present in the atmosphere. Methane is another important – and potent – greenhouse gas. Due to the natural greenhouse effect, the average temperature on Earth is 14 °C.

As long as the natural quantity of gases is present, this effect is good. Without the natural greenhouse effect, life as we know it would not be possible because our planet would be too cold. If these greenhouse gases become more abundant, however, they will retain too much heat, further increasing the Earth's surface temperature.

For millions of years, the concentration of greenhouse gases in the atmosphere has more or less been in equilibrium, with vegetation – especially forests – absorbing excess carbon dioxide, thereby maintaining a stable global temperature.

What is the human-induced greenhouse effect?

The human-induced greenhouse effect has arisen because people have started emitting large quantities of greenhouse gases, mainly by burning fossil fuels. As the concentration of greenhouse gases in the atmosphere increases, more and more heat is trapped, causing the global temperature to rise and changing the climate.

We burn fossil fuels to provide energy for various purposes, such as to power our cars and aeroplanes, manufacture the goods we use, and generate electricity.

Clearing and burning forests also contribute to the greenhouse effect because they release greenhouse gases such as carbon dioxide into the atmosphere. In tropical and subtropical countries, agricultural expansion accounts for 73 percent of deforestation.[2]

The production of livestock, especially cattle, is another important cause of global warming. Cattle emit large quantities of methane.

Picture 2.1. A factory emitting smoke and other pollution

Picture 2.2. Intense livestock farming

What are the impacts of the human-induced greenhouse effect on climate and forests?

The average temperature on Earth has risen considerably over the last century due to the human-induced greenhouse effect.

Climate change affects all regions of the world. For example, the melting of the polar icecaps is causing sea levels to rise everywhere. The impacts of climate change may vary between regions – for example, there may be increases in extreme storms and rainfall in some regions and more drought in others.

Global warming is also causing the oceans to heat up, leading to more evaporation and an increase in intense rainfall and other extreme weather events on land. Africa is particularly threatened by climate change: in the Sahel, for example, temperatures are projected to increase by as much as 8 °C by 2100.[3] Increased droughts and floods could lead to major crop losses, increase food insecurity and deplete the continent's immense biodiversity. Intense flooding and drought events are already making some regions uninhabitable, with people losing their homes and livelihoods.

Many forests are vulnerable to climate change. Increases of as little as 1 °C in mean annual air temperature can cause changes in the growth and regeneration capacity of many forest tree species and in some cases could cause forest cover to disappear completely.[4] Also, the risk of forest fires is expected to increase with higher temperatures and decreased precipitation due to climate change. Forest degradation and destruction can have major negative impacts on people's livelihoods and deprive them of essential forest products such as food, woodfuel and medicines.

Picture 2.3. Flooding

Picture 2.4. Melting glaciers

Picture 2.5. Dry soil

LESSON 5

What is the greenhouse effect?

5

Preparation for the lesson

- Copy the illustration of the natural greenhouse effect (Figure 2.1) onto the board.

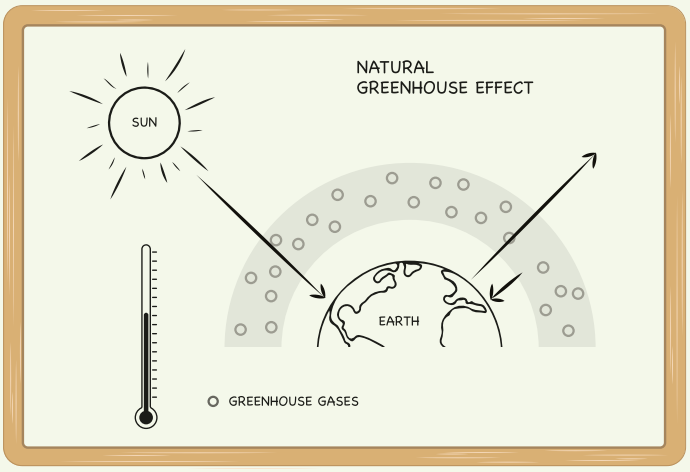


Figure 2.1. The natural greenhouse effect

- If space allows, also draw a greenhouse on the board (Figure 2.2) and use it to help explain the greenhouse effect.

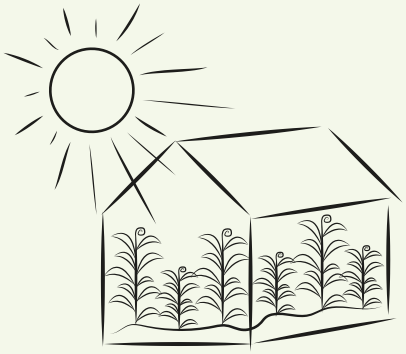


Figure 2.2. A greenhouse

1 Activity 1: Brainstorm on what the greenhouse effect is

indoor This activity should take **25 minutes**.

1. Tell the pupils that they are going to learn about climate change and the greenhouse effect.
2. **Explain:** The Earth is warming up. The higher temperatures are causing big changes in the climate, with droughts and floods becoming more extreme. Rapid changes in climate can jeopardize food production and destroy the habitats of animals and plants. The Earth is becoming warmer because of the greenhouse effect.
3. Ask the pupils if they have heard of a greenhouse and, if they have, whether they know what it is used for. Invite some pupils to answer.
4. **Explain:** Greenhouses are buildings made of a transparent material such as glass. This lets in sunlight and traps some of the heat inside, so it is warmer in a greenhouse than in the open air, even at night. In cold environments, this extra warmth helps protect young plants from the cold and enables them to grow more quickly.
5. Tell the pupils that the Earth's atmosphere is like the glass in a greenhouse, helping keep the planet warm. Now, however, the greenhouse effect is working too extensively, and the planet is becoming dangerously warm.
6. Point to Figure 2.1and **explain**:
   - During the day, the sun's rays pass through the atmosphere – which is like the glass in a greenhouse.
   - Some of these rays are absorbed by the Earth's surface but others are reflected, especially by light-coloured surfaces such as snow, sand and bare ground.
   - Some of the heat in the reflected rays disappears into space, but some of it is absorbed by gases in the atmosphere and re-emitted in all directions, including towards the Earth. These gases are called greenhouse gases.
   - The natural greenhouse effect makes the Earth warm enough to support human life and the rest of the planet's rich biodiversity. Without the natural greenhouse effect, we wouldn't be here today.
7. Tell the pupils that they will now learn how humans have changed the greenhouse effect.
8. Add cows, factory buildings, cars and aeroplanes to the drawing on the board (shown in darker grey in Figure 2.3). Don't forget to increase the temperature in the temperature gauge, and to add more greenhouse gases in the atmosphere.

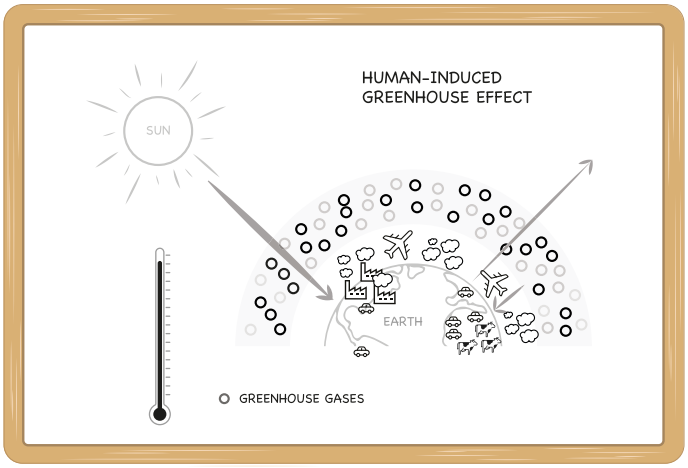


Figure 2.3. The human-induced greenhouse effect

9. **Explain:**
   - People are increasing the concentration of greenhouse gases in the atmosphere, leading to an increase in the global temperature. This is known as the human-induced greenhouse effect.
   - Starting about 200 years ago, especially in Europe and North America, people have been burning vast quantities of coal, oil and gas, releasing the carbon that was previously locked away underground into the atmosphere, mainly as carbon dioxide.
   - Clearing and burning forests, as well as burning wood, also contribute to the human-induced greenhouse effect because they release the carbon stored in trees, other vegetation and soils into the atmosphere.
   - The production of livestock, especially cattle, is another important cause of global warming. Cattle emit large quantities of methane in their flatulence and burps.
   - These activities, along with others (such as energy, transport and industry), have led to an increase in the amount of greenhouse gases in the atmosphere. This means more trapped heat – and a warmer planet.
10. Summarize for the pupils by writing the following sentences on the board. (Do not erase Figure 2.3 because pupils will need to copy it in the next activity.)
    - The natural greenhouse effect – without it, it would be too cold to live on Earth.
    - The human-induced greenhouse effect – it's causing additional warming and changing the climate.

2 Activity 2: Explain the human-induced greenhouse effect

This activity should take **15 minutes**.

1. Ask the pupils to copy Figure 2.3 and the two sentences into their exercise books.
2. Encourage the pupils to show their drawings to their parents and to explain what they have learned about the natural and human-induced greenhouse effect.

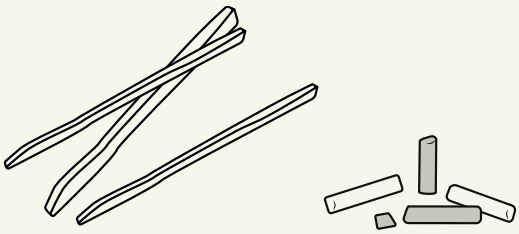
Tip: By presenting what they have learned to their parents, the pupils will repeat and deepen their knowledge. If they are uncertain about anything when presenting their newly acquired knowledge, the pupils may ask their classmates or teacher for clarification and then explain the concepts again at home.

LESSON 6

Play a greenhouse effect game

6

Required materials



SEVERAL STICKS
OR A PIECE OF CHALK
to mark the playing field in the schoolyard

Preparation for the lesson

In the schoolyard, mark a start line and a finish line on the ground using sticks or chalk. The lines should be about 10 m (metres) long. The distance between the start and finish lines should be 15–20 m.

1 Activity 1: Mimic the natural greenhouse effect

outdoor

This activity should take **15 minutes**.

1. Instruct the pupils to go outside, taking their exercise books with them.
2. Do not tell the pupils the title of the activity because they will have to guess the name of the game at the end of the lesson.
3. Organize the class into two groups of equal size – group A and group B.
4. Explain that, one after the other, the two groups will play a game related to what they learned in the previous lesson. Both groups should listen carefully to your explanation of the game.
5. Ask the pupils in group A to line up at the start line. Choose four pupils who will later represent carbon dioxide molecules and ask them to stand next to you. Ask group B to observe the game quietly.

Tip: Group B will play a similar game in the next activity, and you will explain the difference later.

6. Explain to the pupils in group A (and refer to Figure 2.4):
   - » You represent the sun's rays, the start line represents the edge of the atmosphere, and the finish line is the surface of the Earth. Your task is to get from the edge of the atmosphere to the Earth's surface.

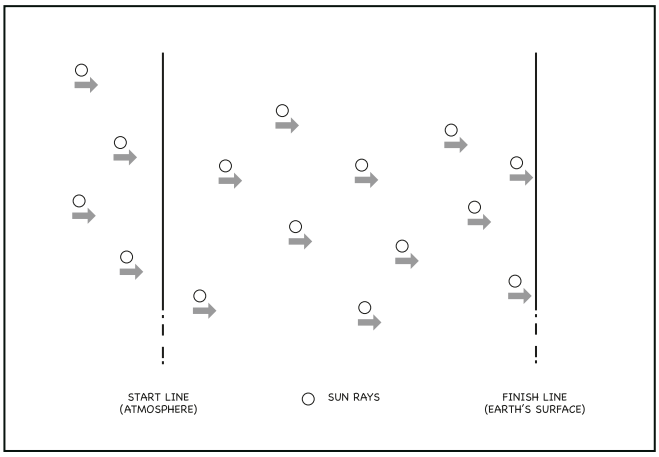


Figure 2.4. How to play the game: (1) the sun's rays

7. Instruct the "sun's rays" (that is, the pupils) to walk or run from the start line to the finish line.
8. Then explain the following (and refer to Figure 2.5):
   - » You have all arrived at the Earth's surface. Now, turn around. You have become heat rays, and you are being reflected back into space. Soon, you are going to try to run back to the edge of the atmosphere (the start line).

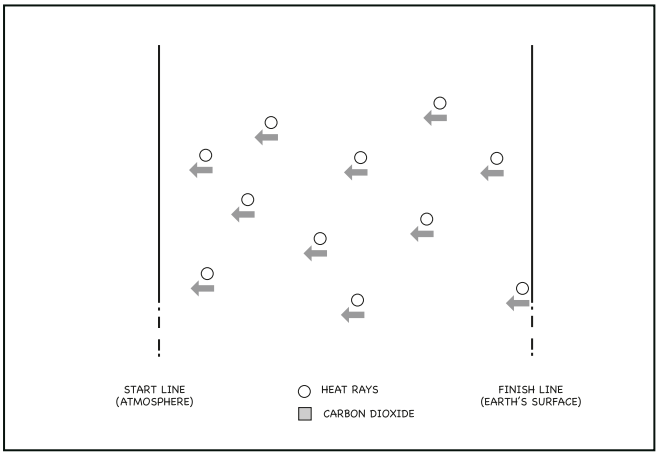


Figure 2.5. How to play the game: (2) reflection of heat rays

9. Send the four pupils representing carbon dioxide molecules onto the playing field between the start and finish lines.
10. **Explain:** In the previous lesson, we learned that some of the heat rays reflected by the Earth towards space are absorbed by greenhouse gases like carbon dioxide in the atmosphere and sent back to the Earth's surface (refer to Figure 1.2).
11. Tell the "heat rays" that, soon, they will try to return to the start line. But the carbon dioxide molecules will try to capture them by touching them. If a carbon dioxide molecule touches a heat ray, the heat ray must return to the Earth's surface (Figure 2.6).
12. Instruct the heat rays to run or walk to the start line.

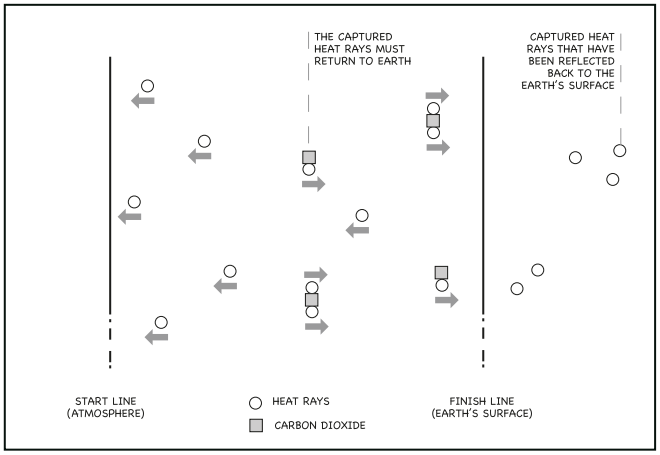


Figure 2.6. How to play the game: (3) capture by carbon dioxide

13. Ask the pupils in group B to count how many heat rays return to the Earth's surface.

2 Activity 2: Understand the human-induced greenhouse effect

outdoor

This activity should take **15 minutes**.

1. Do not tell the pupils the title of the activity because they will need to guess it at the end.
2. Ask the pupils in group B to line up at the start line.
3. In this variation of the game, select eight to ten pupils to act as carbon dioxide molecules to capture the heat rays.
4. Repeat the game in the same way as in Activity 1, but with eight to ten carbon dioxide molecules rather than four.
5. Ask the pupils in group A to count how many heat rays return to the Earth's surface.

3 Activity 3: Reflect on what you learned

outdoor

This activity should take **10 minutes**.

1. Ask the pupils to tell you how many heat rays were reflected back to the Earth's surface in the game played by group A ("Activity 1") and then in the game played by group B ("Activity 2").
2. Remind the pupils about what they learned in the previous lesson and ask them what the different results in the two games might mean.
   - Which game represented the natural greenhouse effect and which represented the human-induced greenhouse effect?
3. Invite some pupils to answer.
4. Tell the pupils that you will now dictate the correct answer and they should write it in their exercise books.

   Answer: Activity 1 represented the natural greenhouse effect and Activity 2 represented the human-induced greenhouse effect. In Activity 2, there were more greenhouse gas molecules in the atmosphere, which meant that more heat rays were reflected back towards the Earth's surface. Therefore, having more carbon dioxide molecules in the atmosphere makes the Earth temperature rise.

LESSON 7

What can we do about the human-induced greenhouse effect?

7

Preparation for the lesson

Draw Figure 2.7 on the board.

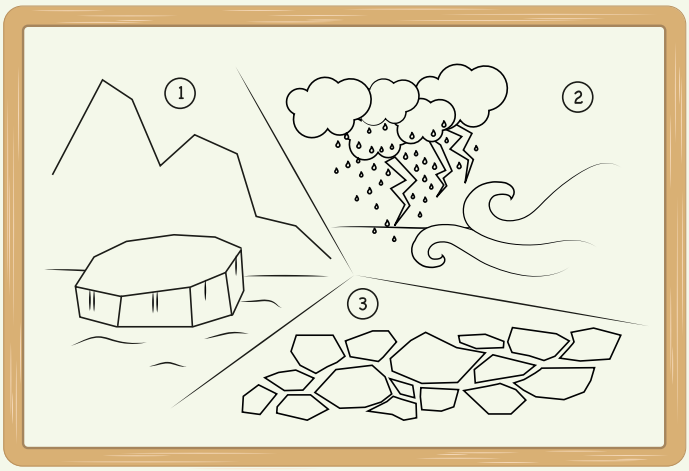


Figure 2.7. (1) Melting icecaps, (2) more intense storms and flooding, and (3) drier soils and more extreme droughts

1 Activity 1: Recap what you previously learned

indoor

This activity should take **5 minutes**.

1. Start the lesson with a recap of the greenhouse effect.
2. **Explain:**
   - » There are two types of greenhouse effect – natural and human-induced.
   - » Without the natural greenhouse effect, the Earth would be too cold to support life.
   - » The human-induced greenhouse effect is mainly the result of burning fossil fuels, as well as deforestation, livestock raising and agriculture, all of which are increasing the concentration of greenhouse gases such as carbon dioxide and methane in the atmosphere.
   - » The human-induced greenhouse effect is leading to rapid global warming and changes in climate.

2 Activity 2: Learn the impacts of the human-induced greenhouse effect on climate

This activity should take **20 minutes**.

1. Ask the pupils what they see in the Figure on the board (Figure 2.7).
   - ► How might they be related to the human-induced greenhouse effect?
2. Allow the pupils a few minutes to think. They may discuss the pictures with other nearby pupils.
3. Ask the pupils again if they know what the three drawings in the Figure have to do with the human-induced greenhouse effect and climate change.
4. For each drawing, invite a pupil to present their ideas.
5. Then **explain:**
   - » The drawings show the effects of global warming on the climate.

     The polar icecaps are melting, causing sea levels to rise.
     → Drawing 1. This is increasing flooding and erosion in coastal areas.

     Oceans are warming up, and more water is evaporating from water bodies.
     → Drawing 2. In some regions, this is producing more intense rainfall on land, leading to more flooding.
     → Drawing 3. In some regions, this is reducing the rainfall and supply of freshwater.

   - » The consequences of the human-induced greenhouse effect will increase as the temperature continues to rise. Africa is facing major impacts. In the Sahel, for example, the temperature is projected to increase by as much as 8 °C by 2100.
   - » An increase in extreme floods and droughts is making some regions increasingly difficult to live in. Some people have lost their homes, food sources and livelihoods and need to move to other areas where the impacts are less severe.
   - » Climate change is likely to have major impacts on forests – some forests could disappear completely, along with their many plant and animal species.
   - » Forest loss can have major negative impacts on the livelihoods of many people, who can no longer benefit from forest products (such as food, wood and medicines) and ecosystem services (such as the provision of clean water).
6. Give the pupils time to think and discuss among themselves their experiences with extreme weather events, such as droughts and storms.
7. Conclude the activity by reiterating that the increasing severity of weather events is due to the actions of humans – the human-induced greenhouse effect.

3 Activity 3: Brainstorm on where the human-induced carbon dioxide emissions come from and how we can reduce them

indoor This activity should take **15 minutes**.

1. In the middle of the board, write "What are the sources of human-induced carbon dioxide emissions?".
2. Ask the pupils if they know where carbon dioxide comes from. Invite two to three pupils to offer ideas, but don't correct them.
3. If the pupils don't suggest all the ideas shown in Figure 2.8, suggest them yourself and write them on the board. Complete the Figure, step by step.
4. Involve the pupils by asking them for examples of each source.

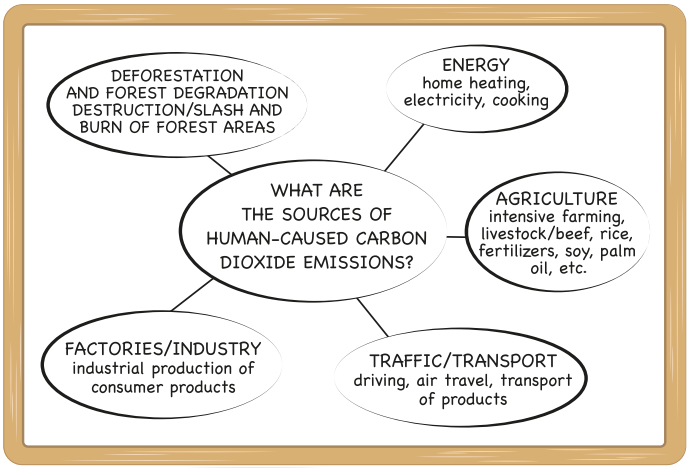


Figure 2.8. What are the main sources of human-induced carbon dioxide emissions?

5. **Explain:**
   - » Large amounts of carbon dioxide are released when fossil fuels such as coal, oil and gas are burnt.
   - » Charcoal and fuelwood also emit carbon dioxide when they are burnt; however, if the forests in which they are harvested are managed sustainably, the carbon will be recaptured when the forest regrows. So, for each tree that has been cut, a new one has to be planted.
   - » We burn these fuels for many purposes, such as:
     - a. **Energy** – fossil fuels are used for heating, electricity and cooking.
     - b. **Transport** – fossil oil is used for cars, aeroplanes, ships and other mechanized transport to move people and goods around the world.
     - c. **Industry** – fossil fuels are burnt to generate electricity and heat for the mass production of consumer goods.

» Other human-related activities that contribute to the release of greenhouse gases and the human-induced greenhouse effect include:

a. **Deforestation and forest degradation** – when forests are cleared, they are no longer able to absorb and store carbon. If forests are burnt, much of the carbon contained in the vegetation and soils is released into the atmosphere.

b. **Farming** – forests are often cleared to make way for crops and livestock grazing. In tropical and subtropical countries, agricultural expansion on forests drives 73 percent of deforestation. Livestock (especially cattle and pigs) contribute directly to the human-induced greenhouse effect because they emit large volumes of methane in their flatulence and burps. Methane is a potent greenhouse gas – a molecule of methane traps much more heat than a molecule of carbon dioxide. It is important, therefore, to find solutions that can help produce food for people without harming the forest.

Preparation for the next lesson

Ask the pupils to each bring in a green leaf and a stone about 5 cm (centimetres) in size. As another option, bring these items in yourself.

Notes

[1] **NASA.** 2022. FAQ: What is the greenhouse effect? In: *Global Climate Change*. Cited 28 March 2022. https://climate.nasa.gov/faq/19/what-is-the-greenhouse-effect

[2] **FAO.** 2022. *Global Forest Resources Assessment – Remote sensing survey.* Rome.

[3] **Campbell, M.M., Casterline, J., Castillo, F., Graves, A., Hall, T.L., May, J.F., Perlman, D. et al.** 2014. Population and climate change: who will the grand convergence leave behind? *The Lancet Global Health*, 2(5): e253–e254. https://doi.org/10.1016/S2214-109X(14)70021-X

[4] **FAO.** 2022. Climate Change Adaptation and Mitigation. Sustainable Forest Management (SFM) Toolbox. Cited 5 April 2022. www.fao.org/sustainable-forest-management/toolbox/modules/climate-change-adaptation-and-mitigation/in-more-depth

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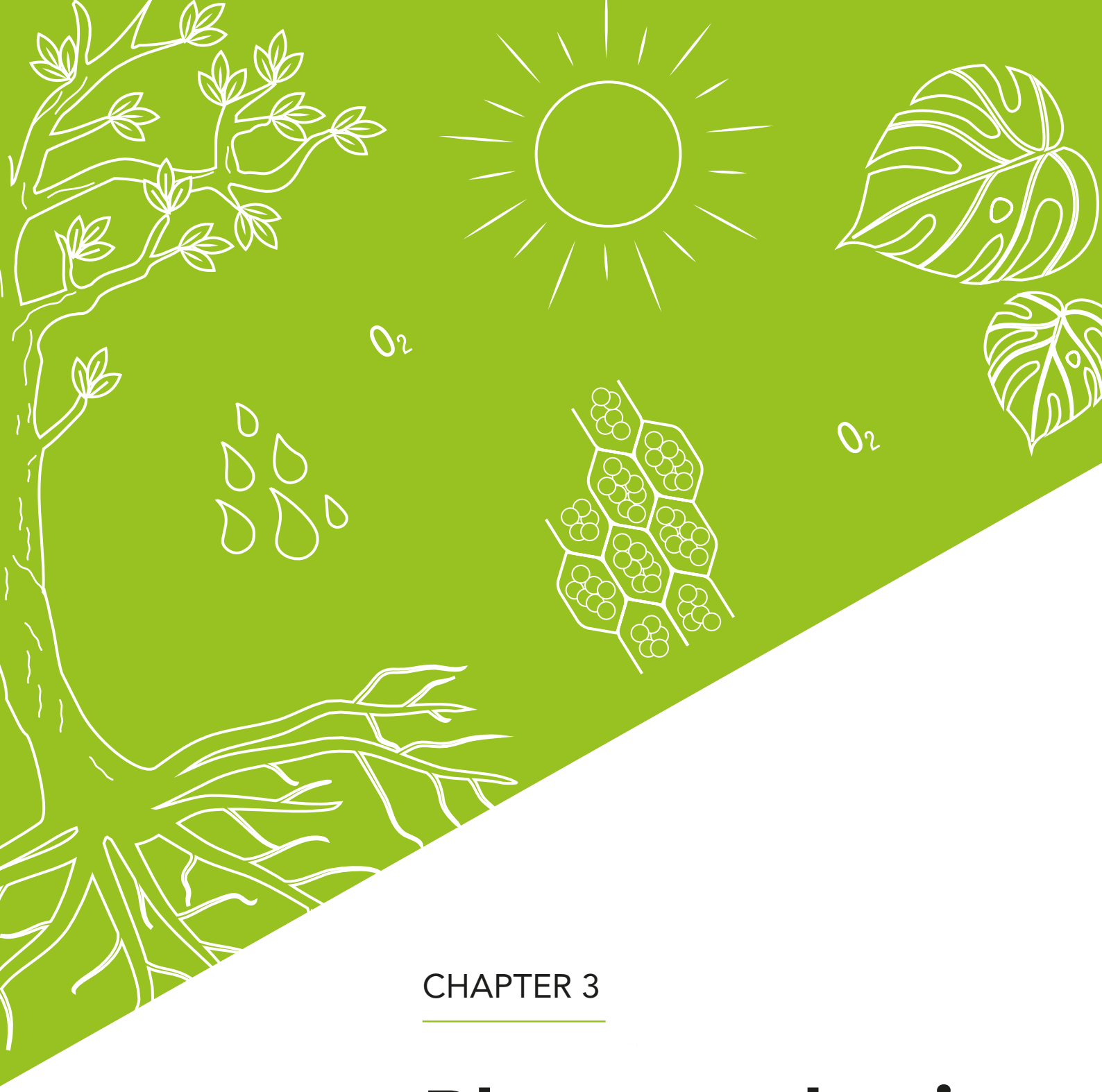

CHAPTER 3

Photosynthesis

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Overview

In this chapter, the pupils will experiment with leaves and run a relay race to learn the basics of photosynthesis. Through discussion and a memory quiz, they will understand the importance of photosynthesis for plants, animals, people and the environment.

Objectives

By the end of the chapter, the pupils will be able to:

- describe what photosynthesis is and how plants and trees use it to feed themselves;
- explain chlorophyll and its function in photosynthesis; and
- explain the importance of photosynthesis for regulating global warming and supporting life on Earth.

Background information

What is photosynthesis?

Photosynthesis is the process by which plants use energy from the sun to convert carbon dioxide and water into glucose (a kind of sugar) and oxygen. Plants use the glucose to grow and to manufacture plant materials – such as bark, flowers and fruit. The oxygen is released into the atmosphere.

Photosynthesis requires the presence of chlorophyll, a green pigment in leaves (and some other plant parts, such as the stems of grasses), which absorbs light from the sun. Chlorophyll is the reason that leaves are green.

All green plants, as well as some species of algae and bacteria (such as cyanobacteria), use photosynthesis to manufacture glucose. As they do so, they "breathe in" carbon dioxide and "breathe out" oxygen.

Plants (both on land and in the sea) are the Earth's main source of oxygen. Oxygen is vital for most lifeforms, including humans.

How does photosynthesis work in trees?

Photosynthesis requires four "ingredients": water, carbon dioxide, sunlight and chlorophyll.

Photosynthesis mainly occurs in green leaves, which are the "food factories" of plants. Leaves can photosynthesize due to the presence of chlorophyll.

Photosynthesis has five main steps in vascular plants:

1. Plant roots absorb **water** from the soil and transport it up the trunk through supply lines called xylem, to the leaves. Xylem comprises bundles of mainly dead cells, which joined end to end, form hollow tubes through which water and minerals move from the roots to all parts of the plant.
2. The leaves absorb **carbon dioxide** from the air through pores (tiny openings) on their surface called stomata.
3. Chlorophyll in the leaves absorbs energy from **sunlight**. Chlorophyll is a green pigment contained in chloroplasts. Chloroplasts are tiny capsules in the cells of leaves (and other green plant parts, such as some stems).
4. Using the energy from the sun absorbed by their **chlorophyll**, chloroplasts transform water and carbon dioxide into glucose.
5. The manufactured **glucose**, which is the food that plants use to grow and reproduce, is transformed into other sugars and transported throughout the plant through supply lines called phloem. Phloem comprises bundles of cells, which joined end to end, form tubes through which glucose (and the liquid in which it is dissolved) flows to all parts of the plant.

As a byproduct of photosynthesis, plants produce **oxygen**. The oxygen is released into the air, where it is available for use by humans and other animals.

Plants release a certain amount of carbon dioxide at night (when they cannot photosynthesize). Nevertheless, over a lifetime, a tree absorbs much more carbon dioxide than it emits, storing most of the excess in the form of wood.

Picture 3.1. Green leaves

Picture 3.2. Pine needles

Why is photosynthesis important?

Photosynthesis plays a key role in life on Earth. It is the main source of the oxygen we breathe. We – and other animals – inhale oxygen when we breathe in and exhale carbon dioxide when we breathe out. Plants (and some algae and bacteria), on the other hand, breathe in (absorb) carbon dioxide and breathe out (emit) oxygen. This is why forests and trees are sometimes called the "lungs" of the planet.

Photosynthesis also has an important effect on the climate. One of the world's biggest problems is the increasing amount of carbon dioxide (a greenhouse gas) in the atmosphere, which is causing the climate to get warmer – this is referred to as global warming (see Chapter 2). Plants capture carbon dioxide from the air during photosynthesis and convert it into glucose. Trees store this glucose, which contains carbon, in their leaves, fruits, stems, trunks, branches and roots, and use it to grow and reproduce. By taking carbon dioxide out of the air, trees and other plants help combat climate change.

Picture 3.3. Forest trees in sunlight

LESSON 8

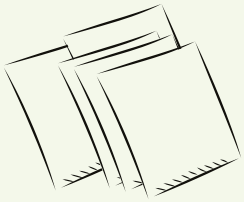
Conduct a leaf experiment

8

Required materials

GREEN LEAVES
(1 per pupil)

STONES ABOUT 5 cm IN SIZE
(1 per pupil)



PAPER
(1 sheet per group of 8–10 pupils, large enough to cover the leaves)

1 Activity 1: Brainstorm on the role of leaves

indoor

This activity should take **20 minutes**.

1. Ask the pupils:
   - What are tree leaves for?
2. Write the responses on the board. Responses may include:
   - Leaves provide shade.
   - Leaves provide food for animals and people.
   - Some leaves can be used as medicine.
   - Leaves produce oxygen.
3. **Explain:** Trees use their leaves to produce glucose (a form of sugar), as well as oxygen. This process is called photosynthesis, and today the class will learn how it works.

Tip: You may explain photosynthesis in more detail using the background information on pages 41–43. Alternatively, you may ask the class the following questions and provide the explanations:

- What makes leaves green?
  - **Answer:** A substance called chlorophyll. We will see this soon.

- ▶ Why is chlorophyll important?
- » **Answer:** Chlorophyll captures sunlight to produce glucose (a form of sugar) from carbon dioxide and water. This is called photosynthesis.
- ▶ What is carbon dioxide?
- » **Answer:** Carbon dioxide is a gas in the air made of carbon and oxygen.
- ▶ Why is photosynthesis important?
- » **Answer:** Photosynthesis enables plants to grow. This is important for people and animals because without plants we would have nothing to eat. Photosynthesis also produces oxygen, which we need to breathe.

4. When the discussion is over, organize the pupils into groups of eight to ten. Give each group a paper.

2 Activity 2: Experiment on crushing leaves

This activity should take **20 minutes**.

1. Tell each group to place its green leaves on a firm patch of ground and cover them with the sheet of paper.
2. Tell the pupils to take turns hitting the paper with a stone, crushing the leaves underneath but trying not to tear the paper. They may do this several times. To prevent injury, only one pupil at a time should hit the paper.
3. Give the groups 10 minutes to do this. At the end, tell them to inspect the undersides of their pieces of paper.

> ! **Note:** Hitting the leaf with the stone will release the chlorophyll from the leaf and colour the paper green.

4. Tell the pupils to think about what they learned in the previous activity and ask them the questions below about the experiment. Invite a few to volunteer answers before explaining further.
   - ▶ What happened in the experiment?
   - » **Answer:** We hit the paper with a stone, and green spots appeared on our sheets of paper.
   - ▶ Where do you think the green colour comes from?
   - » **Answer:** From the leaves.
   - ▶ What do you think it is?
   - » **Answer:** Chlorophyll, the green leaf pigment.
   - ▶ Why do plants need chlorophyll?
   - » **Answer:** Chlorophyll absorbs sunlight to produce the plant's food – glucose – via photosynthesis.
5. **Explain:** The green spots on the paper are chlorophyll, the green leaf pigment. Chlorophyll captures sunlight to produce the plant's food – glucose – via photosynthesis.

LESSON 9

How does photosynthesis work? 9

1 Activity 1: Learn how photosynthesis works

indoor This activity should take **20 minutes**.

1. Ask the pupils to briefly recall what they discovered in the "crushing leaves" experiment in the previous lesson.
2. Ask the same questions as in the last lesson (repeated below) to enable the pupils to strengthen their knowledge through repetition. Provide the answers, if necessary.
   - ► What happened in the experiment?
   - » **Answer:** We hit the paper with a stone, and green spots appeared.
   - ► Where do you think the green colour comes from?
   - » **Answer:** From the leaves.
   - ► What do you think it is?
   - » **Answer:** Chlorophyll, the green leaf pigment.
   - ► Why do plants need chlorophyll?
   - » **Answer:** Chlorophyll absorbs sunlight to produce the plant's food – glucose – via photosynthesis.
3. Draw Figure 3.1 and ask the pupils to copy it into their exercise books.

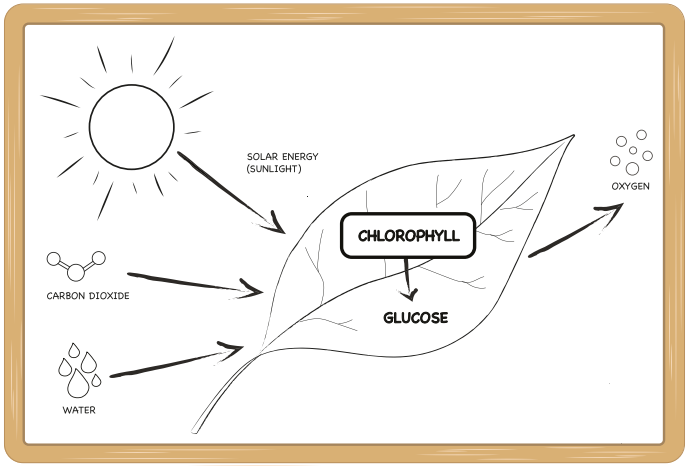


Figure 3.1. Photosynthesis

4. Explain the process of photosynthesis, using Figure 3.1 and the explanation below. Point to each item in the drawing as you explain.
   - **Green leaves** contain chlorophyll, which is a green pigment that gives plants their colour. The pupils saw this substance when crushing leaves in the previous lesson.
   - **Water** is absorbed from the soil by the tree's roots.
   - **Sunlight** shines on the chlorophyll in the leaves.
   - **Carbon dioxide** is a gas that exists naturally in the air. Plants absorb it through pores (tiny openings) in their leaves.
5. Afterwards, write the following sentences on the board and ask the pupils to copy them into their exercise books.
   - » Plants need sunlight to produce glucose through photosynthesis.
   - » The plant's leaves absorb carbon dioxide from the air. The plant's roots take up water from the soil.
   - » Chlorophyll in leaves absorbs the sun's rays and uses this solar energy to convert carbon dioxide and water into glucose and oxygen.
   - » Glucose is a kind of sugar. It is produced via photosynthesis and is converted into other sugars that the plant uses to grow and reproduce.

2 Activity 2: Discuss links between photosynthesis and the greenhouse effect

This activity should take **20 minutes**.

1. Ask the pupils:
   - ► Do you know why photosynthesis is important?
2. Invite some pupils to answer. Answers the pupils might give (based on previous activities) include the following:

   Possible answer:
   - » Plants use photosynthesis to produce their food. Without photosynthesis, there would be no plants, trees or forests.
   - » Plants produce oxygen that humans and other animals need to breathe.
3. Add another key point about why photosynthesis is important:
   - » Photosynthesis has an important influence on the climate connected to the greenhouse effect. You will learn why in this activity.
4. Recap with the pupils what they learned about the greenhouse effect in Chapter 2. Draw Figure 3.2 on the board and remind the pupils that they saw the same picture in Chapter 2.

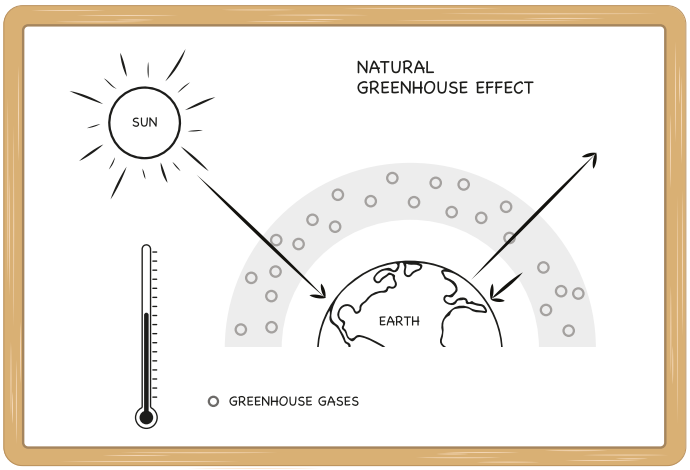


Figure 3.2. The natural greenhouse effect

5. Ask the pupils to explain the greenhouse effect by posing the following questions.
   - What is the greenhouse effect?
   - » **Answer:** The greenhouse effect is the warming of the Earth that occurs when gases in the atmosphere trap heat from the sun that otherwise would be reflected back into space.
   - What causes the greenhouse effect?
   - » **Answer:** The greenhouse effect is caused by gases in the air, such as carbon dioxide and methane, which reflect heat rays back to Earth. These gases are called greenhouse gases.
   - Why is the greenhouse effect causing the climate to change?
   - » **Answer:** Human activities are producing too much carbon dioxide and other greenhouse gases. The higher concentration of greenhouse gases in the atmosphere is reflecting more heat back to the Earth, causing the planet to get warmer.
   - Where do carbon dioxide and other greenhouse gases come from?
   - » **Answer:** Humans release greenhouse gases by burning fossil fuels such as oil, coal and gas to generate electricity, manufacture goods and move around the country and the planet in cars, trains, aeroplanes and ships. Daily human activities such as cooking, heating, turning on the lights, watching television and listening to the radio all contribute to carbon dioxide emissions. Livestock such as cattle and pigs emit a lot of methane with their flatulence and burps; methane is a potent greenhouse gas.

6. Add cows, factory buildings, cars and aeroplanes to the drawing on the board (shown in darker grey in Figure 3.3). Don't forget to increase the temperature in the temperature gauge, and to add more greenhouse gases in the atmosphere.

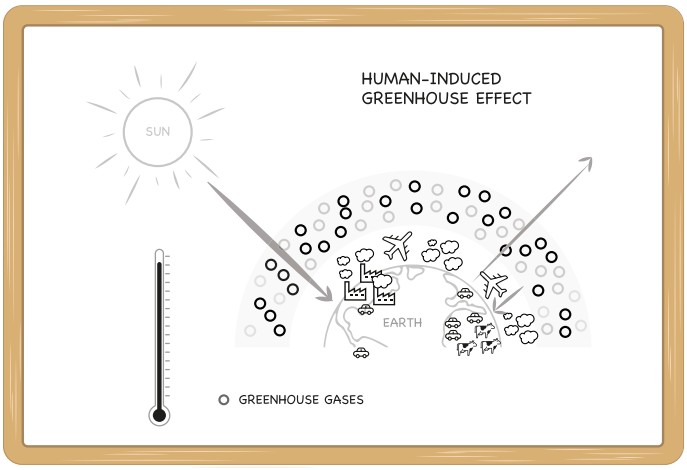


Figure 3.3. The human-induced greenhouse effect

7. **Explain:** About 200 years ago, there was a better balance between the carbon dioxide emitted by humans, other animals and sources such as volcanoes and forest fires, and the carbon dioxide absorbed by trees and other plants.
8. Now that you have recapped the greenhouse effect, ask the pupils:
   - ► Why are photosynthesis and plants important for maintaining a liveable temperature on Earth?
9. Allow the pupils a few minutes to think and to share their answers.
10. **Explain:**
    - » Photosynthesis is important for our climate.
    - » Trees absorb carbon dioxide from the air during photosynthesis and convert it into glucose.
    - » This glucose is stored in the leaves, stems, trunks, branches and roots of trees, which use it as food to grow and produce new wood.
    - » Trees and other plants can therefore help reduce global warming by storing the carbon absorbed from the air as carbon dioxide.
    - » At the same time, trees and plants emit oxygen, which humans and other animals need to breathe.

LESSON 10

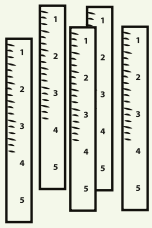
Run a photosynthesis relay race

10

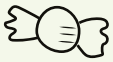
Required materials

5 TABLE SPOONS

5 BOTTLES FILLED WITH WATER



5 RULERS



1 PIECE OF CANDY PER PUPIL

10 CONTAINERS FOR THE CANDIES

5 CUPS
(e.g. yoghurt pots)

Preparation for the lesson

Before the lesson starts, mark a start line and a finish line on the ground in the schoolyard. The distance between the lines should be 10–20 m (metres). The lines must be long enough (about 20 m) to enable five groups to run a relay race, side by side.

1 Activity 1: Recap the photosynthesis process

indoor This activity should take **10 minutes**.

1. Read out the following explanation of photosynthesis to remind the pupils of what they have learned so far and to prepare them for some of the concepts addressed in the relay race.
2. **Explain:**
   - » The leaves of trees and other plants are like small factories. They absorb carbon dioxide from the air and water from the soil. With the help of sunlight and chlorophyll, they convert carbon dioxide and water into glucose and oxygen.
   - » Photosynthesis is sometimes called the basis of life because it produces oxygen, which humans and other animals need to breathe, and glucose, which enables plants to grow.
   - » Trees can help reduce global warming by capturing carbon dioxide from the air through photosynthesis and storing it as carbon when they make wood.

2 Activity 2: Perform the photosynthesis process

outdoor This activity should take **30 minutes**.

1. Organize the class into five teams of equal size. Instruct the teams to go to the start line and line up. Each team should form a queue, one pupil behind another. There should be a comfortable distance between each team.
2. Tell the pupils that:
   - » Each team symbolizes a tree (see Figure 3.4).
   - » The starting line represents the tree's roots and the soil in which it grows.
   - » The finish line represents the treetops.
   - » The candies represent glucose (the sugar produced by photosynthesis).
3. At the start line, give each team a bottle filled with water (representing the water taken up by the roots from the soil), a tablespoon and an empty container for the candies. These should all be placed at the start line.
4. At the finish line, place an empty cup and a container with enough candies so there is one for each member of the team.
5. Explain to the pupils that the goal is to transport as much water to the cup (using the spoon) and to collect as many candies as possible. The team that collects the most water and most candies wins – it will mean that their "tree" has absorbed the most water and produced the most glucose.

6. Ask the pupils to listen carefully to your explanation and instructions, as follows:

   - **Phase 1 – from the start line to the finish line.**

     Explanation: Photosynthesis takes place in the leaves. The sun shines on the leaves; the leaves absorb carbon dioxide from the air; and water is brought up from the roots through the xylem (hollow tubes for transporting water and nutrients).

     Instructions for the game: Tell the first pupil in each team to pour some water into their spoon and to carry it carefully to the finish line (that is, to the "treetop"). The task is to spill as little water as possible. When the pupils arrive at the finish line, they must pour the water from the spoon into the cup.

   - **Phase 2 – from the finish line to the start line.**

     Explanation: Using energy from the sun, the leaves make glucose from carbon dioxide and water. The glucose produced by photosynthesis is distributed to all parts of the plant through a network of hollow tubes called phloem. The candies symbolize the glucose produced during photosynthesis. Some of the food is stored in the roots and some is used to grow and to manufacture plant materials – such as bark, flowers and fruit.

     Instructions for the game: Tell the pupils who brought spoonfuls of water to the finish line to pick up a candy (representing glucose), put it on their spoons and carry it back to the starting line (the roots). When the pupils get back to the start, they should put their candies into the container there. If the candy falls off the spoon it must be left where it lands, and the pupil must continue walking back to the group without the candy. As soon as a pupil arrives back at the start line, they should place the candy (if they still have it) in the empty container and pass their spoon to the next pupil in their team, who then repeats the relay. In this way, the race continues until all pupils have taken their turn.

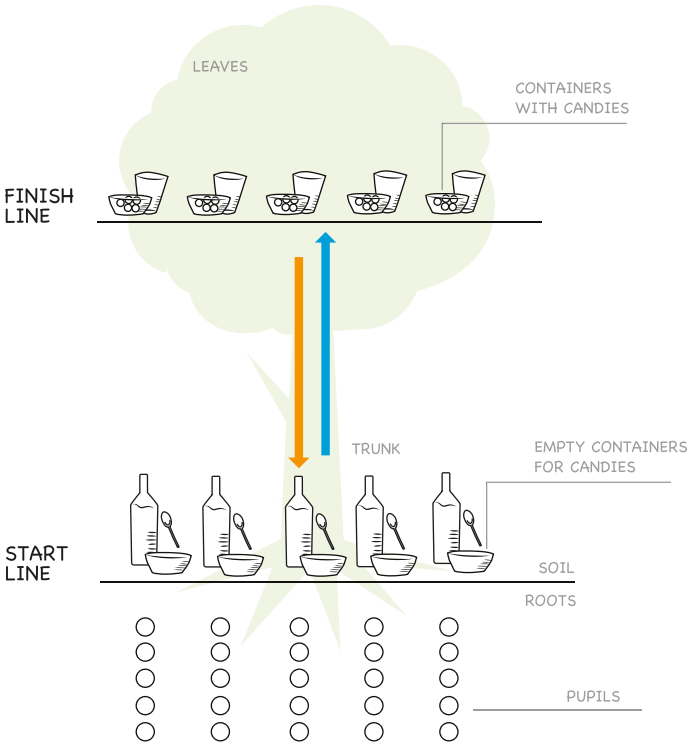


Figure 3.4. The photosynthesis relay

7. Then, measure the results.
   - How many candies does each group have?
   - How much water did each group collect in the cup?

Note:
- Dropped candies do not count.
- Water can be measured by using a measuring cylinder or conical flask or, if these are unavailable, by dipping a ruler into the water in each cup. If the cups differ in size, use the same cup to measure all the results.

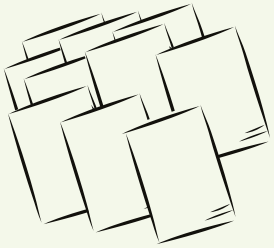
8. To find the strongest tree (team), multiply the number of candies by the quantity of water (measured in millimetres or centimetres of water depth in the cup).
   - Example: A group collected a total of 15 candies and 3 cm (centimetres) of water. The equation would be: $15 \times 3 = 45$.
9. The group with the most points wins. It is the strongest tree that grew the most.
10. Remind the class that, during photosynthesis, plants also produce oxygen, which is released into the air.

LESSON 11

Play a photosynthesis guessing game

11

Required materials



20 MANILA CARDS

1 MARKER PEN

Preparation for the lesson

- Prepare 20 quiz cards. On ten cards, write the ten questions below about photosynthesis (one question per card). On the other ten cards, write the answers to the questions (the answers are also given below).

  - ► **Why do trees have leaves?**
  - » **Answer:** Leaves produce food that trees need to grow and reproduce.
  - ► **What is produced during photosynthesis?**
  - » **Answer:** Glucose and oxygen.
  - ► **Where does photosynthesis take place?**
  - » **Answer:** In the leaves.
  - ► **What is chlorophyll?**
  - » **Answer:** Chlorophyll is the green pigment in leaves.
  - ► **Why is photosynthesis sometimes described as the basis of life?**
  - » **Answer:** Photosynthesis produces oxygen, which animals need to breathe, and glucose, which plants need to grow.
  - ► **What is required for photosynthesis?**
  - » **Answer:** Sunlight, water, carbon dioxide and chlorophyll.

- **How does water get to the leaves for photosynthesis?**
  - **Answer:** Water is absorbed by the tree's roots and transported up the trunk to the leaves through the xylem.
- **Why do trees need photosynthesis?**
  - **Answer:** Photosynthesis enables trees to make glucose, which they need to grow and reproduce.
- **How can photosynthesis help reduce global warming?**
  - **Answer:** Too much carbon dioxide is making the planet hotter. Photosynthesis removes carbon dioxide from the atmosphere.
- **What do trees do with the carbon they absorb?**
  - **Answer:** They store it by growing and manufacturing plant materials – such as bark, flowers and fruit.

- The question cards should be marked with a big "Q" and the answer cards marked with a big "A" for easy identification.

1 Activity 1: Guess the correct answer on photosynthesis

This activity should take **30 minutes**.

1. Organize the class into 20 teams.
2. Give the quiz cards to the teams.
   - Ten teams should have **question** cards (one card per team).
   - Ten teams should have **answer** cards (one card per team).
3. Ask one of the teams with a question card to start. A member of the team will read the question aloud.
4. Teams that think they have the correct answer should raise their hands. Pick one team and ask a member of the team to read the answer aloud.
   - If the answer is correct, ask the other teams with question cards to raise their hands. The team that answered the question correctly will choose the next question team.
   - If the answer is wrong, the class continues to look for the correct answer.
5. The quiz continues until all the questions have been answered correctly.
6. If pupils raise further questions during the quiz, you may invite others to suggest answers, correcting them if necessary.

2 Activity 2: Discuss the importance of photosynthesis for the climate

This activity should take **10 minutes**.

1. Write the following sentences on the board and ask the pupils to copy them into their exercise books. They will also find the sentences in their pupils' books.
   - » There is too much carbon dioxide in the air, mainly because humans are burning so much coal, oil and gas.
   - » Photosynthesis is sometimes called the basis of life because it produces oxygen, which humans and other animals need to breathe, and glucose, which enables plants to grow and reproduce.
   - » Trees can help reduce global warming by capturing carbon dioxide from the air through photosynthesis and storing it as carbon when the tree grows wood.
2. Ask the pupils the following question as a way of encouraging further reflection:
   - ► How can we increase the contributions of trees and wood to combating climate change?

     Possible answers:
   - » Plant more trees.
   - » Use sustainably harvested wood to make furniture, construct buildings, and so on.
   - » Stop destroying forests.

Note: If time allows, stimulate discussion by asking further questions in bold:

- » Plant more trees. - **But don't we need the same land to grow crops?**
- » Use sustainably harvested wood to make furniture, construct buildings, and so on. - **What happens to the carbon dioxide then? So cutting trees down might sometimes be a good thing?**
- » Stop destroying forests. - **Does this mean we can't cut trees down? Or is it okay to cut trees down, use the wood to build houses and furniture, and grow more trees to replace the felled trees?**

Preparation for the next lesson

Ask the pupils to look around the school and their homes for any forest products used to produce energy (e.g. wood for cooking or heating).

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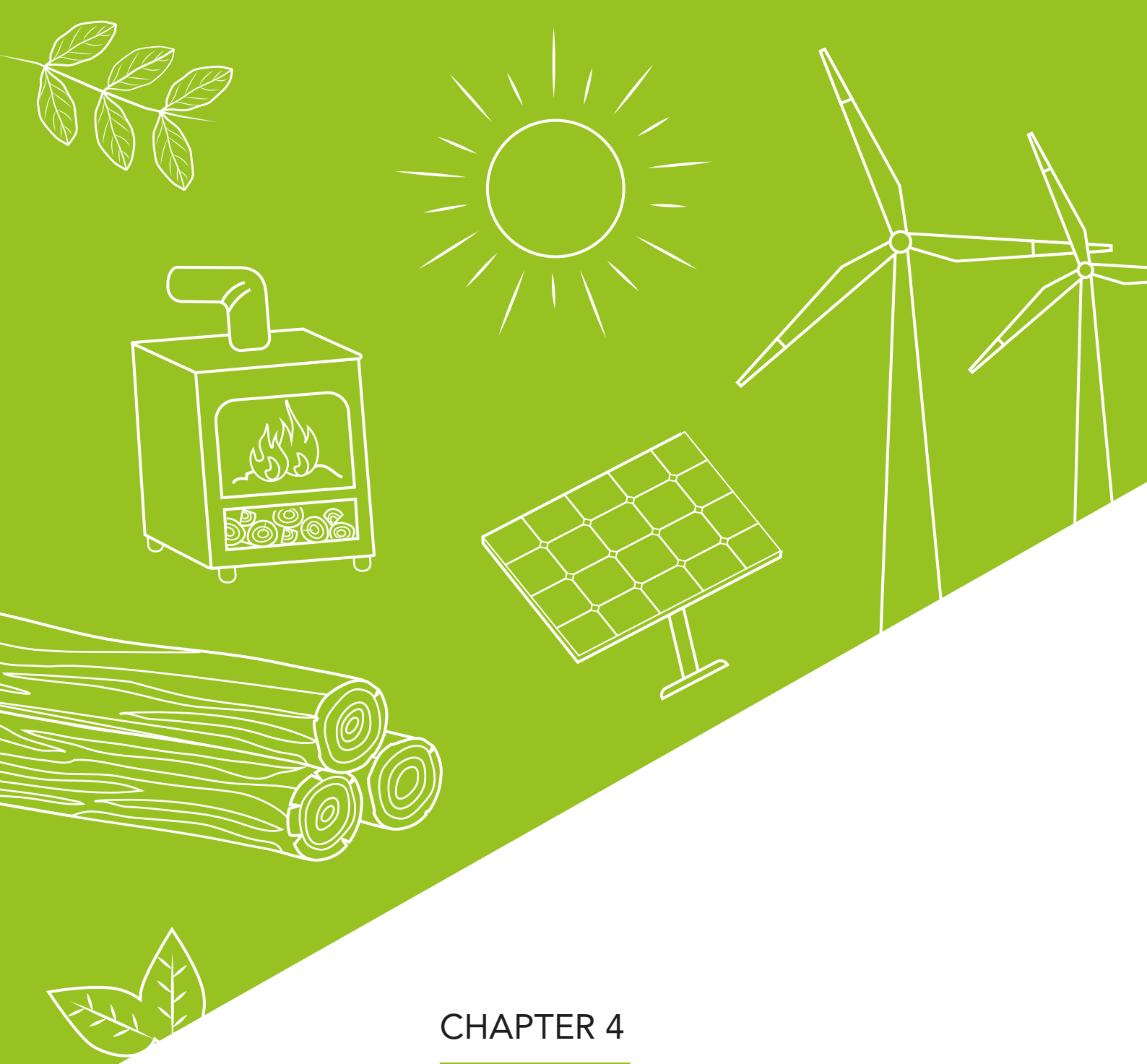

CHAPTER 4

Wood and other sources of renewable energy

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Overview

In this chapter, the pupils will learn the difference between renewable and non-renewable energy and be able to give examples of both. They will participate in an exercise of imagination using wood as a form of renewable energy, and they will discuss the advantages and disadvantages of wood as an energy source.

Objectives

By the end of the chapter, the pupils will be able to:

- provide a basic definition of energy;
- describe the differences between renewable and non-renewable energy, and identify and explain different types of renewable energy;
- explain why it is essential to consider sustainability when using wood as an energy source; and
- understand the main advantages and disadvantages of wood energy.

Background information

What is renewable energy and why is it important for the environment and our lives?

We need energy to cook our food, heat and cool our homes, run household appliances and drive our cars.

There are many sources of energy. For example, electricity can be generated from fossil fuels such as coal, oil and gas and from wind, sunlight, and wood and other biomass. Energy sources may be non-renewable or renewable.

- **Non-renewable energy sources** cannot be replenished. Non-renewable sources of energy such as coal, oil and gas are the fossilized remains of plants and animals that fell to the bottom of ancient oceans and swamps and, over millions of years, were buried under sediments and compressed and transformed into the fuels we use today. Given how long these sources of energy took to form, when they run out, they will be gone forever.
- **Renewable energy sources** can be replenished. Solar energy is available whenever the sun shines, and wind energy can be harvested whenever the wind blows. Other potentially renewable sources of energy are hydroelectricity and biomass such as woodfuel. Woodfuel is only renewable if it is produced in sustainably managed forests.

Fossil fuels release large quantities of carbon dioxide and other greenhouse gases when burnt and therefore are a major contributor to the human-induced greenhouse effect and climate change (see Chapter 1 and Chapter 2).

Renewable energy sources such as the sun, wind, water and wood release less carbon dioxide and therefore contribute less to climate change.

Is wood a renewable source of energy?

When forests are managed carefully, wood is a renewable, climate-friendly source of energy. This is because trees grow back after harvesting, replenishing the wood supply.

Wood can only be used in limited quantities, however, because trees take a relatively long time to grow back. Burning wood releases smoke, which causes air pollution and can have negative effects on human health. If wood is not sourced sustainably, using wood for energy can contribute to forest loss and harm the environment.

Steps for ensuring that wood energy is sustainable and causes minimal harm include the following:

- Use energy-efficient wood-burning stoves for heating and cooking.
- Harvest forests sustainably, which means removing no more wood than can grow back before the next harvest.
- Complement wood energy with other renewable energy sources, such as solar, wind and hydroelectricity.

Picture 4.1. Coal, a non-renewable energy source

Picture 4.2. Fuelwood, a renewable energy source

What technologies are available for using renewable energy?

Efficient technologies enable us to make the most of renewable energy resources. They include the following:

- **Wind turbines** use the wind to generate electricity, with a single large turbine capable of supplying electricity to hundreds of households. In a typical device, three blades are attached to a central tower, which can be 100 m (metres) tall or more. Wind turns the blades, which drive a generator, which converts the mechanical energy of the turning blades into electricity, which is sent to the power grid. The rotating blades can be dangerous for bats and birds.
- **Hydroelectricity power plants** are mostly built below dam walls and waterfalls. As water flows down, it turns the blades of a turbine, which drives a generator, which converts the mechanical energy of the turning blades into electricity, which is sent to the power grid.

- **Solar panels** use the sun to generate electricity. More solar energy hits the Earth in 1 hour than all the energy we use worldwide in 1 year. The sun's energy is almost infinite – but the sun only shines during the day. Solar panels can send electricity to batteries to be used later and to central power grids.
- **Wood-burning stoves and ovens** enable people to use wood as an energy source for cooking and heating. Wood is a source of renewable energy only if the forest from which it comes is managed sustainably. This means that tree regrowth must be at least equal to the volume of wood harvested to ensure that forests stay healthy and the resources don't degrade over time. In many parts of the world, woodfuel production and consumption cannot be considered sustainable because trees are cut down and burnt faster than they are planted and can regrow.

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Picture 4.3. Wind turbines

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Picture 4.4. A hydroelectricity plant

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Picture 4.5. Solar panels

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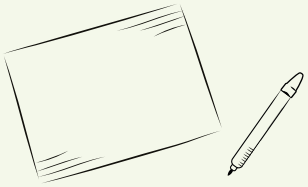
Picture 4.6. A wood-burning stove

LESSON 12

What are the sources of energy?

12

Required materials



1 MANILA SHEET AND
1 MARKER PEN
(alternatively, you may draw
the pictures on the board)

Preparation for the lesson

Before the class starts, draw the pictures in Figure 4.1 on the board and label the Figure, "Renewable energy sources and technologies". You will explain these images to the pupils later. You may wish to post the pictures on the classroom wall for an extended period to deepen the pupils' understanding.

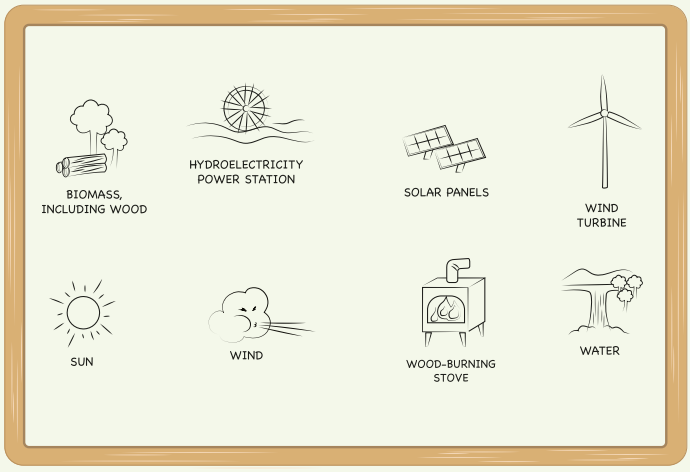


Figure 4.1. Renewable energy sources and technologies

1 Activity 1: Brainstorm on energy sources

indoor This activity should take **20 minutes**.

1. Ask the pupils to define energy:
   - What is energy?
2. Invite a few pupils to answer.
3. **Explain:** Energy is power – it makes things move and change. We need energy to move our bodies, cook our food, heat a room, turn on a light and drive a car down the road.
4. Ask the pupils about the energy sources that they use at home and in school (e.g. wood, electricity, gas and batteries). Ask the pupils if they know where the energy comes from (e.g. power plants, generators, solar panels, the forest or a river). Invite about five pupils to answer. At this point, do not confirm whether the pupils' answers are right or wrong.
5. Copy Figure 4.2 onto the board.

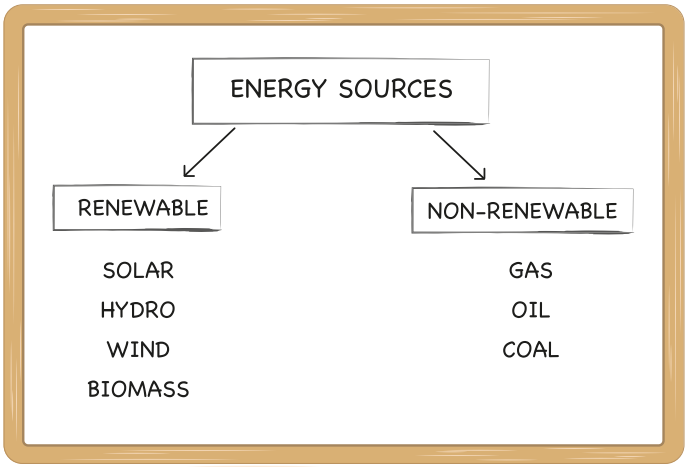


Figure 4.2. Energy sources

6. Explain the difference between renewable and non-renewable energy, as follows:
   - **Renewable energy** can be replenished. Solar energy is available whenever the sun shines, and wind energy can be harvested whenever the wind blows. Other potentially renewable sources of energy include hydroelectricity, which generates energy from flowing water, and biomass such as woodfuel. Woodfuel is only renewable if it is produced in sustainably managed forests.
   - **Non-renewable energy** is energy that cannot be replenished. Non-renewable sources of energy such as coal, oil and gas are the fossilized remains of plants and animals that fell to the bottom of ancient oceans and swamps and, over millions of years, were buried under sediments and compressed and transformed into the fuels we use today. Given how long these sources of energy took to form, when they run out, they will be gone forever.
7. Ask the pupils why the sun, wind, water and biomass in Figure 4.2 are called renewable.

8. Allow pupils to suggest answers before **explaining:**
   - The sun always shines – except at night (also, less electricity is generated on cloudy days).
   - The water used for hydroelectricity can be replenished upstream by rainfall and snowmelt – although the supply might diminish during droughts or if the water is overused for irrigation.
   - Wind is caused by the uneven heating of the Earth and is driven by the sun, so we might expect that it will always be around. Sometimes the wind doesn't blow, though.
   - Trees and plants can be replanted, but we have to manage forests sustainably. This means not harvesting more wood than can grow back before the next harvest.

2 Activity 2: Explore energy sources and technologies for using them

This activity should take **15 minutes**.

1. Use the drawings you made earlier (Figure 4.1: "Renewable energy sources and technologies").
2. **Explain:**
   - The sun, wind, water and biomass are all renewable sources of energy.
   - Various technologies are needed to use these resources to produce energy.
3. Ask the pupils to copy the drawings into their exercise books. Then, instruct them to match the energy source to the technology that uses it by connecting the drawings with lines.

> **Tip:** The correct answers are given below and are shown in Figure 4.3, but do not reveal them to the pupils until the next step.

Sun → solar panels

Wind → turbine

Trees and other plants (biomass) → stove

Water → hydroelectricity power station

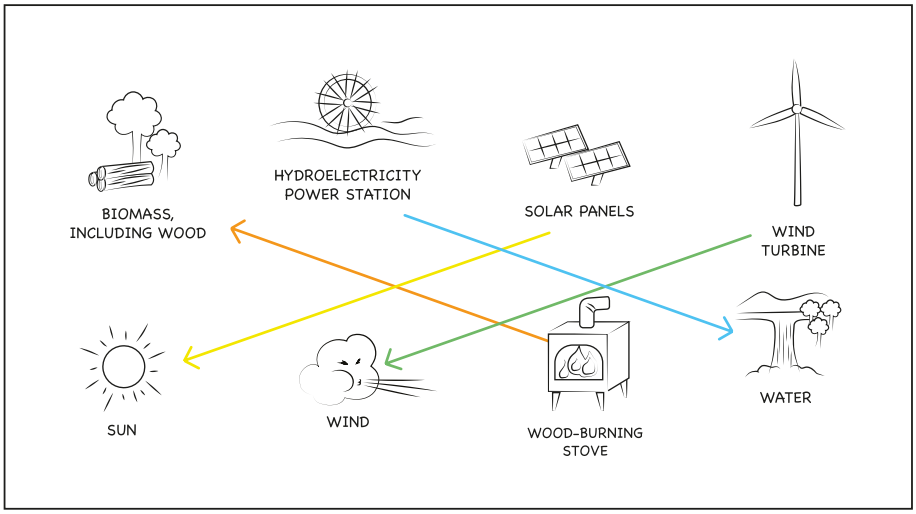


Figure 4.3. Which technologies are used for which energy sources?

4. After about 10 minutes, ask a few pupils to indicate which technology they assigned to each energy source.
5. **Explain:**
   - **Solar panels use the sun to generate electricity.** More solar energy hits the Earth in 1 hour than all the energy we use worldwide in 1 year. The sun's energy is almost infinite – but the sun only shines during the day. Solar panels can send electricity to batteries for storage and to a central grid.
   - **Wind turbines use the wind to generate electricity.** A single wind turbine can supply electricity to hundreds of households. In a typical device, three blades are attached to a central tower, which can be more than 100 m tall (equivalent to a 30-storey building). Wind turns the blades, which drive a generator, which creates electricity. The electricity is sent to the power grid for general use. The wind doesn't blow all the time, however, and the rotating blades can be dangerous for bats and birds.
   - **Hydroelectricity power plants use flowing water to generate hydroelectricity.** They are mostly built below dam walls and waterfalls. The flowing water turns the blades of a turbine, which drives a generator, which creates electricity, which is sent to the power grid.
   - **Wood energy can be harnessed in various ways.** The most common way is in wood-burning stoves and ovens for cooking and heating. Wood counts as a renewable energy source only if the forest from which it comes is managed sustainably. This means not cutting down more trees than the forest can grow back. In many regions of the United Republic of Tanzania, woodfuel production and consumption cannot be considered sustainable because trees are cut down and burnt faster than they regrow.

Preparation for the next lesson

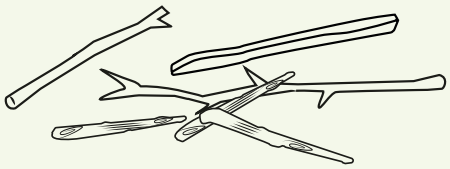
Tell the pupils that, in the next lesson, they will build an imaginary fire in the schoolyard. To do so, ask them to bring in small sticks, branches and other pieces of wood that they can use to build a fire. If fires are permitted in your area and can be lit safely, consider making a real fire, which will be an exciting prospect for the pupils. As another option, bring these items in yourself.

LESSON 13

Focus on fire

13

Required materials



SMALL STICKS, BRANCHES AND PIECES OF WOOD
(brought in by the pupils)

1 Activity 1: Learn the rules for dealing with fire

outdoor

This activity should take **5 minutes**.

1. Tell the pupils that, in this lesson, they will make an imaginary fire.

> **Tip:** If fires are permitted in your area and can be lit safely, consider making a real fire, which will be an exciting prospect for the pupils. If you do make a real fire, make sure you obtain permission from the school principal and any other relevant authorities. Follow all safety rules and fully extinguish the fire at the end of the lesson.

2. Explain that, when setting a fire outdoors, people should always adhere to the following rules to ensure safety.
   - Check with local authorities that fires are permitted in the area and on the specific day.
   - Always remain calm and focused and stand at a safe distance from the fire.
   - Only set fires in open areas, with no nearby flammable materials such as dried grass, overhanging branches or scrub.
   - Avoid lighting fires in hot, dry and windy conditions.
   - Never leave a fire unattended.
   - Have a bucket of water nearby in case the fire gets out of control.
   - Make sure fires are fully extinguished when you have finished with them.
   - Never play with fire!

3. Organize the pupils in a semicircle around you.
4. Ask them if this would be a good place to build a fire. Ask them if there are any overhanging branches or nearby dry grass or other flammable materials, or if it is too near a building.
5. Tell the pupils that there should be no flammable materials for at least 3 m in all directions of the fireplace, and nothing (e.g. powerlines or branches) overhead. Fires should be avoided in hot, dry and windy conditions.

2 Activity 2: Explore the human-induced greenhouse effect

This activity should take **15 minutes**.

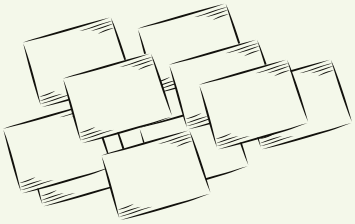
1. Explain to the pupils that they will now build an imaginary fire.
2. Ask the pupils to place their sticks, branches and other pieces of wood in a pile and to sit around the pile. (If you have a real fire, you will need to adjust points 3, 7 and 8 below accordingly.)
3. Ask if any pupils have ever made a fire outside. Invite a few pupils to tell the class how they did it.
4. Ask the pupils to pretend that they are sitting around a real fire. They should try to imagine the sensations of it, such as the heat, the colour of the flames, the smell of the smoke and the sound of the crackling wood.
5. Ask if any pupils have ever cooked food on an open fire. Talk about what they cooked and how they cooked it.
6. Ask the pupil:
   - ► What does making a fire have to do with energy?
   - » **Answer:** When we burn wood, it creates heat that we can use to cook food. Wood is a source of energy.
7. Ask the pupils:
   - ► Have you ever noticed the smoke when you have cooked on a fire? (Ask them to imagine what the smoke would feel like if they were sitting around a real fire).
   - » **Answers:** It smells, it is hot, it makes you cough, and it makes your eyes burn.
8. **Explain:**
   - » Wood smoke releases many substances into the air. This causes air pollution, which can have a negative effect on our health. About 3 billion people around the world cook using open fires or simple stoves fuelled by kerosene, biomass such as wood, animal dung and crop waste, and coal.
   - » Nearly 4 million people die every year from illnesses related to the smoke caused by the use of inefficient, polluting stoves. Even in the United Republic of Tanzania, thousands of people die each year from indoor air pollution (33 000 Tanzanians died from indoor air pollution in 2016).
   - » It is better for our health to use cooking stoves (like mud stoves) that burn wood efficiently and produce less smoke. Efficient cooking stoves produce about 63 percent fewer greenhouse gas emissions than traditional stoves, so they're also better for the climate.
9. If you have lit the fire, ensure that it is fully extinguished before returning to the classroom, and check it again later.

LESSON 14

What is renewable energy?

14

Required materials



10 MANILA CARDS

1 MARKER PEN

ADHESIVE TAPE

1 Activity 1: Discuss the advantages and disadvantages of wood energy

indoor This activity should take **10 minutes**.

1. Ask the pupils to describe what they did in the previous lesson.
2. Then ask the following questions, writing them on the board as you go. If necessary, complete the pupils' answers and write them on the board as well.

► What do we use the energy produced by burning wood for?

» **Answer:** We use it to cook and to heat our homes.

Explain: Wood is not the only form of biomass that can be used to produce energy. (Biomass is any organic material – which means it comes from plants and animals.) Biomass energy sources include crops such as corn, waste plant materials from farms, animal manure and human sewage, biodegradable household materials and food waste, and wood and wood-processing waste. Biomass can be burnt directly for heat or converted into renewable liquid and gaseous fuels. It can also be used to generate electricity.

- What are the advantages of using wood as an energy source?

  Possible answers:

  - Wood grows back (it is renewable).
  - Wood can be used in various forms (e.g. charcoal, wood pellets and briquettes).

Explain: Globally, 6 percent of energy comes from wood. In many countries in Africa, wood accounts for 90 percent or more of all energy used.

- What are the disadvantages of using wood as an energy source?

  Possible answers:

  - The supply of wood is limited because trees grow quite slowly.
  - Burning wood releases smoke, which causes air pollution and can harm our health.
  - If wood is not sourced sustainably, using wood for energy can contribute to forest loss and damage the environment.

3. Ask the pupils to copy the question and answers into their exercise books.

2 Activity 2: Learn the difference between renewable and non-renewable energy

This activity should take **15 minutes**.

1. Ask the pupils if they remember the difference between renewable and non-renewable energy.
2. Invite some pupils to provide answers. Then write on the board:
   - Renewable energy sources can be replenished.
   - Non-renewable energy sources cannot be replenished.

3. **Explain** another important difference between these forms of energy:
   - Using non-renewable energy sources such as coal, oil and gas releases a lot of carbon dioxide, which is one of the main causes of global warming and climate change.
   - Using renewable energy sources such as the sun, wind, water and biomass releases much less carbon dioxide. So, these energy sources are better for the climate.

4. Draw Figure 4.4 and the following statements on the board. Ask the pupils to copy the statements into their exercise books.
   - » Using renewable energy produces less carbon dioxide. This is better for the climate!
   - » Non-renewable energy produces a lot of carbon dioxide. This is bad for the climate!

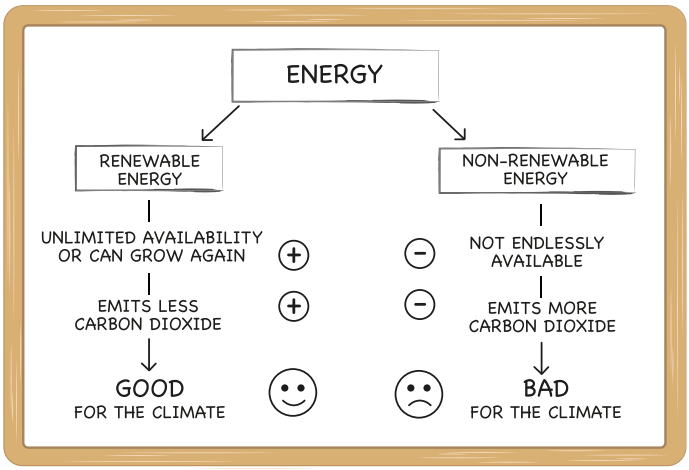


Figure 4.4. Renewable versus non-renewable energy

3 Activity 3: Repeat what you learned

indoor This activity should take **15 minutes**.

1. Copy Figure 4.5 onto the board. Explain that it symbolizes wood as an energy source.

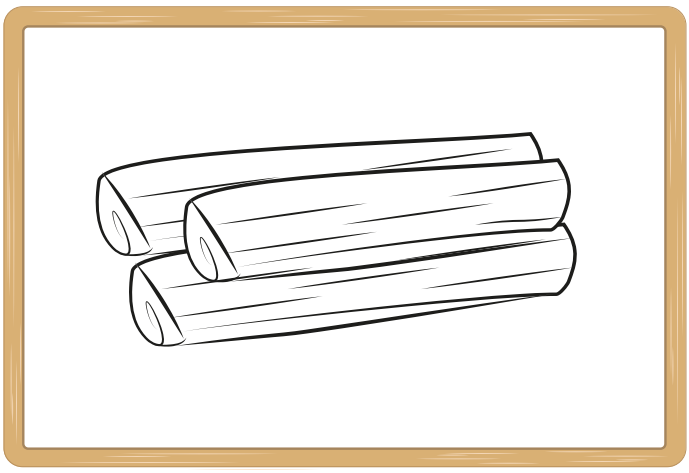


Figure 4.5. Wood as an energy source

2. Ask the questions below and invite the pupils to answer.
   - » If they give the correct answer, hand them a manila card. Ask them to write a short version of the answer on it (in just a few words – help them to formulate this if necessary) and to stick it beside the drawing on the board. Ask different pupils to answer different questions.
   - » If the pupils do not know an answer, provide it. Write the correct answer on a manila card and stick it beside the drawing.

   Questions:

   - ▶ Is wood a renewable or a non-renewable energy source?
   - » **Answer:** It is a renewable energy source if we use wood from well-managed forests.

   - ▶ What are some advantages of using wood as an energy source?

     Possible answers:

   - » Wood grows back (it is renewable).
   - » Wood can be used for energy in various forms (e.g. charcoal, wood pellets and briquettes).

   - ▶ What are some of the disadvantages of using wood as an energy source?

     Possible answers:

   - » The wood supply is limited because trees grow quite slowly.
   - » Burning wood releases smoke, which causes air pollution and can affect our health.
   - » If wood is not sourced sustainably, using wood for energy can contribute to forest loss and harm the environment.

   - ▶ How can we use wood as an energy source carefully and responsibly?

     Possible answers:

   - » **We can use wood sustainably by not using more wood than will grow back.**
   - » **We can make people more aware of the need to use wood sustainably.**
   - » Where possible, we can use other renewable energy sources, such as the sun, wind and water.
   - » We can reduce wood use by using energy-efficient stoves.

3. Read the two sentences in bold above and ask the pupils to copy them into their exercise books.

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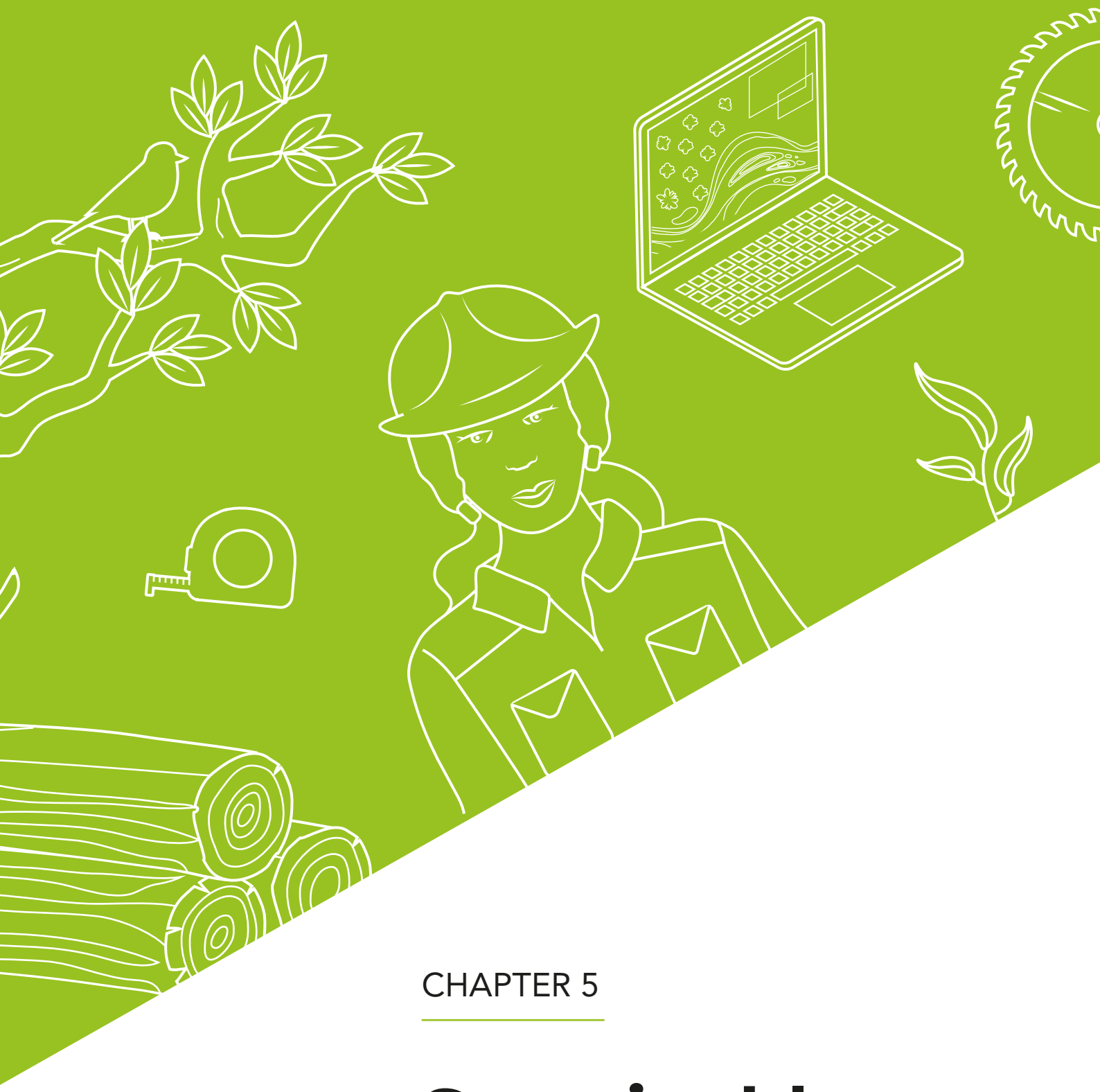


CHAPTER 5

Sustainable forest management

Overview

In this chapter, the pupils will learn why sustainable forest management is necessary and about the consequences of unsustainable forestry. They will review the content of previous lessons on the multiple roles of forests, learn about the negative impacts on forests that can arise from human activities and unsustainable use, and recognize the importance of sustainable forest management for maintaining the multiple roles of forests. The pupils will learn through a movement game and reflect creatively on the principles of sustainable forest management by making a Möbius strip.

Objectives

By the end of the chapter, the pupils will be able to:

- explain the concept of sustainable forest management;
- explain the principles of sustainable forest management; and
- describe the consequences of unsustainable forest management for people and nature.

Background information

What is sustainable forest management?

Sustainable forest management (also called "sustainable forestry") encompasses all the human activities that take place in a forest – such as planning, harvesting, tree-planting and fire management. It is conducted in such a way as to ensure that the forest continues to provide benefits for users over time while maintaining its wide range of values and roles.

Forest management can have different objectives in different forests. In some forests, for example, the focus may be on conservation and in others it may be on wood production.

Forests in the United Republic of Tanzania cover about 48 million ha (hectares), which is more than half the mainland area,[1] and support the livelihoods of many communities. Sustainable forest management is essential for conserving these forest areas and ensuring their sustainable use.

The aim of sustainable forest management in protected forests is mainly to ensure good-quality freshwater and the conservation of biodiversity. Human activities such as timber harvesting are usually restricted or forbidden in such forests. The primary aim of production forests is to produce wood for various purposes. In such forests, sustainable forest management is essential for ensuring a continual timber supply.

What are the impacts of unsustainable forest management?

Poor forest management and unsustainable tree harvesting can lead to forest degradation and deforestation, with the following potential consequences:

- **Biodiversity loss.** Forest degradation and the clearing of large areas of forest can lead to the loss of species and their habitats.[i]
- **Habitat fragmentation.** Logging, forest clearing and the building of infrastructure such as roads can fragment forests and habitats. This can have serious long-term impacts on wildlife species by restricting their movement and migration and reducing interactions between populations of species.[ii]
- **Climate change.** Forest clearing and degradation can affect local climates by altering the water cycle and reducing the cooling effects of forests. Moreover, deforestation causes the emission of greenhouse gases, thereby contributing to climate change (see Chapters 1, 2 and 3).
- **Loss of livelihoods.** Forests play important roles in the livelihoods of many people, and their degradation or loss reduces the access of such people to forest foods, medicines, wood and forest-related employment.[iii]

We need sustainable forest management to maintain the many roles of forests over time.

Picture 5.1. A forest area being burned by a human made fire

Picture 5.2. Example of illegal logging and deforestation

[i] For more information on biodiversity in the forests of the United Republic of Tanzania, see Module 1, Chapters 1, 4 and 5 and Module 2, Chapters 2, 3 and 6.

[ii] For more information, see Module 1, Chapter 1.

[iii] For more information, see Module 2, Chapters 1–9.

Why is sustainable forest management important for people?

In recent centuries and decades, many millions of hectares of forests worldwide have been cleared for agriculture and to provide space for cities. The demand for land has led to uncontrolled deforestation, the loss of livelihoods for many people who depend on forests, and widespread environmental damage. Today, more than 90 percent of global deforestation takes place in the tropics, and 73 percent of tropical and subtropical deforestation is due to agricultural expansion.[2] Considerable deforestation is occurring in Africa today.[3]

The aim of sustainable forest management is to ensure that forests can provide their diverse products and ecosystem services for the benefit of people, now and in the future. Under sustainable forest management, people can earn money from sustainable forest use while also ensuring that forests stay healthy and productive over time. Earning money from sustainable forestry reduces the need to clear forest for other purposes.

Forests capture carbon from the air and store it in wood and soils. Managing forests sustainably ensures that forests can continue to perform this function, thereby helping combat climate change.

Picture 5.3. Sustainable forest management

LESSON 15

Why do we need forests?

15

1 Activity 1: Discuss why we need forests

indoor

This activity should take **40 minutes**.

1. Start the lesson with the following description of forests in the United Republic of Tanzania:
   - » The United Republic of Tanzania has more than 48 million ha of forest, which means that a little more than half the country's total land area has forest on it. This natural resource supports communities and livelihoods.
2. Then write the following question on the left-hand side of the board (the first column in Figure 5.1):
   - ► Why do we need forests?
3. Invite the pupils to answer the question. Possible responses include:
   - » Forests give us wood, which we use to make products such as furniture, houses and paper.
   - » We can use wood as fuel to cook and to heat our homes.
   - » Forests give us food and medicines.
   - » Forests produce oxygen, which we need to breathe.
   - » Forests store carbon, which helps combat climate change.
   - » We use forests to relax in.
   - » Forests are important for the water cycle and help ensure we have clean drinking water.

> **Tip:** It is not important that the forest functions learned so far are mentioned in detail. It is more important that the pupils remember at the beginning of the lesson that forests provide us with a wide range of services and are an important basis for life on Earth.

4. Write the pupils' responses on the board below the question, "Why do we need forests?".
5. Summarize by saying that forests have many important roles, and write a plus sign ("+") next to the roles mentioned.
6. Ask the pupils to copy the answers into their exercise books.
7. Next, **explain:** When we use a forest, we affect the ecosystem. Human activities such as cutting down trees, collecting food and hunting animals can have consequences for the forest.
8. Ask the pupils about the consequences that human activities might have for forests.
9. Write the following question in the middle of the board (see Figure 5.1):
   - ► What impacts can human activities have on the forest? (If possible, talk about forests growing nearby and ask the pupils to think about what might happen if people took more and more wood or other products from them.)
10. Invite some pupils to volunteer ideas.

Possible answers:

- The forest will disappear, and the animals that rely on the forest for food and habitat will also vanish.
- If more and more trees are felled, the forest will become smaller and smaller and eventually disappear altogether.

11. Write the pupils' answers on the board and, if necessary, add to the list from the following:
    - biodiversity loss;
    - habitat fragmentation;
    - climate change; and
    - loss of livelihoods for local people.
12. Summarize by saying that human interventions in a forest always have consequences, which can cause forest destruction.
13. Draw a minus sign ("-") above the list of consequences.
14. Ask the pupils to copy the list into their exercise books.
15. Now write the following question on the right-hand side of the board (see Figure 5.1):
    - ► What does sustainable forestry mean?
16. **Explain:** Sustainable forest management means using no more wood and other forest resources than will grow back before the next harvest. It also means using forests in ways that maintain their many roles over time. "Sustainable forestry" and "sustainable forest management" have the same meaning.
17. Write this explanation on the board (see Figure 5.1) and ask the pupils to copy it into their exercise books.
18. Finally, **explain:** There are laws in the United Republic of Tanzania to ensure that forests are not overexploited and destroyed. Good laws are important for encouraging sustainable forest management and discouraging overexploitation. You will learn more about this in Chapter 6.

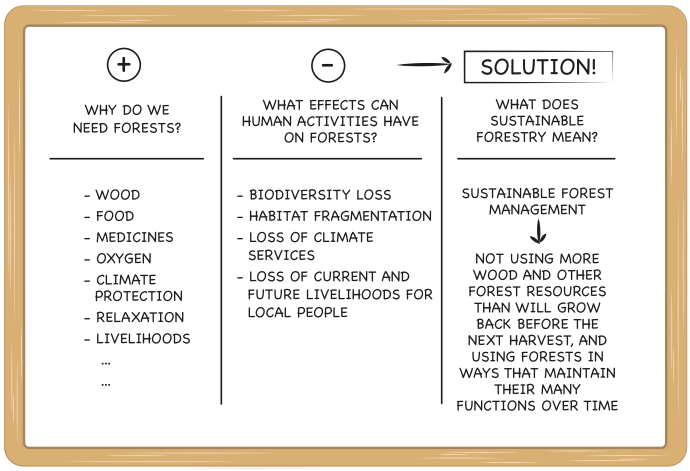


Figure 5.1. The meaning of sustainable forestry

Preparation for the next lesson

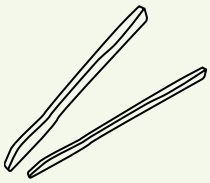
The next lesson needs to be prepared in advance. The instructions are given on the next page. Ask the pupils to each bring in two sticks, about 30 cm (centimetres) long for the next lesson. As another option, bring these items in yourself.

LESSON 16

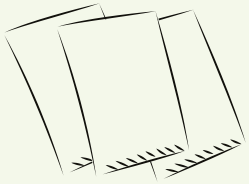
Play a sustainability game

16

Required materials



2 STICKS PER PUPIL
(brought by the pupils)



3 SHEETS OF PAPER

Preparation for the lesson

Mark out a playing field in the schoolyard according to Figure 5.2. The playing field consists of a triangle, with each of the three sides 10 m (metres) long. Place one of three sheets of paper, labelled "Human", "Forest" and "Time", at each tip of the triangle. If you wish, you may also draw the sides of the triangle on the ground using a stick (the arrows in Figure 5.2 show the direction in which the pupils will run; they will be important for explaining the game).

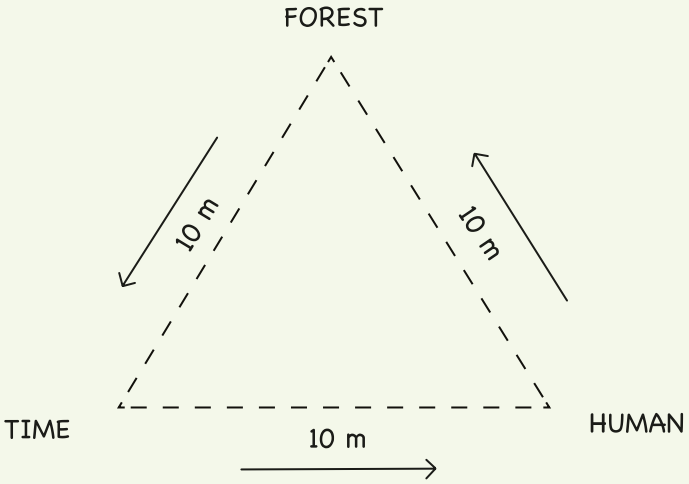


Figure 5.2. The forest sustainability game

1 Activity 1: Appreciate the importance of sustainability (game preparation and explanation)

outdoor This activity should take **15 minutes**.

1. Organize the class into three groups of equal size. Label one group "Human", one "Forest" and the other "Time".
2. Ask each group to count the number of sticks they have, redistributing sticks if necessary so that each group has the same quantity.
3. Then **explain:**
   - As soon as I say so, go with your group to the point of the triangle where your group name is written (i.e. "Human", "Forest" or "Time").
   - Put all your group's sticks in a pile.
   - Stay there quietly until I explain your next task.
   - The game will only begin when I give the start signal.
4. When the groups have done as instructed and are in their respective places on the playing field, go to each group in turn and give them their instructions, as shown below.
   - **Human group:** On the start signal, a pupil from the Human group will run to the Forest group and pick up two sticks, which they will quickly take back to the Human group and place on the group's stick pile. Then, just like in a relay race, the next pupil will also run to the Forest group and fetch another two sticks, return to their group, and place the sticks on the pile. The game will continue in this way until one of the three stick piles becomes empty.
   - **Forest group:** At the start signal, a pupil from the Forest group will run to the Time group and fetch one stick, which they will quickly take back to the Forest group and place on the stick pile. This represents the trees in the forest growing back over time. Then, just like in a relay race, the next pupil will also run to the Time group, fetch another stick, return to their group, and place the stick on the pile. The game will continue in this way until one of the three stick piles becomes empty.
   - **Time group:** At the start signal, a pupil from the Time group will run to the Human group and fetch one stick, which they will quickly take back to the Time group and place on the stick pile. This represents the wood consumed by humans over time. Then, just like in a relay race, the next pupil will also run to the Human group, fetch another stick, return to their group, and place the stick on the pile. The game will continue in this way until one of the three stick piles becomes empty.

Important: The rules of the game must be communicated to each group separately so that no group knows how many sticks the other groups are allowed to take.

2 Activity 2: Appreciate the importance of sustainability (game)

outdoor This activity should take **25 minutes**.

1. Give the start signal.
2. The groups should now collect sticks according to the instructions.
3. The game finishes when one of the stick piles becomes empty. Because the Human group will take two sticks at a time from the Forest group, the Forest group's supply will soon become empty.
4. Ask the pupils:
   - ► Why did the game end?
   - » **Answer:** The humans have taken more from the forest than could grow back before the next harvest. They were NOT using the forest sustainably!
5. Ask the pupils:
   - ► What do you think we could have done differently to avoid running out of forest?
6. Allow them time to brainstorm together and then to volunteer answers.

   Possible answers:

   - » We should take no more wood or other forest resources than will grow back before the next harvest, and we should use the forest in ways that maintain their many roles over time.
   - » We should be aware of and obey the laws in place in the United Republic of Tanzania to ensure that forests are not overexploited and destroyed.

LESSON 17

Create a sustainable forestry Möbius strip

17

Required materials

A SMALL BALL
OR A PIECE OF PAPER
CRUMPLED INTO A BALL

5 A4 SHEETS

AT LEAST 5 GLUE STICKS
OR GLUE BOTTLES

2 PENCILS PER GROUP
(use coloured pencils if possible)

A PAIR OF SCISSORS

Preparation for the lesson

Cut strips of A4 paper lengthwise, each about 2–3 cm (centimetres) wide (see Figure 5.3). You will need one strip of paper per group (there may be more than ten groups – see Activity 2).

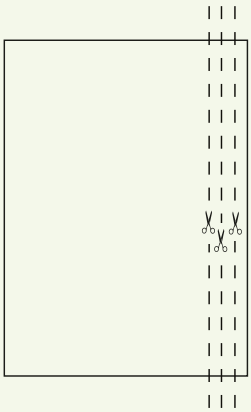


Figure 5.3. The forest sustainability game

Tip: To be able to make the Möbius[iv] strip with the pupils and explain the concepts during the lesson, it is very important that the teacher becomes familiar with the production of the Möbius strip beforehand, including by making one.

[iv] The Möbius strip is named after August Ferdinand Möbius, a German astronomer and mathematician, who described it in the middle of the nineteenth century. A Möbius strip usually has only one side and one edge – that is, one cannot distinguish between the bottom and the top or between the inside and the outside. It is therefore a symbol representing infinity.

1 Activity 1: Discuss the importance of sustainable forestry

indoor This activity should take **15 minutes**.

1. Ask the pupils:
   - Why is sustainable forest management important?
2. They should think about what they learned in the previous two lessons before answering.
3. Throw the ball to a pupil who volunteers to answer the question.
4. If the answer is correct, the pupil may throw the ball to another pupil, who should also provide an answer. Allow several pupils to give answers in this way (each answer must be different). If an answer is wrong, correct it and continue the game.

   Possible answers:

   - Forests will eventually be destroyed if they are not used sustainably.
   - It will enable the continued use of the forest, now and in the future.
   - It can ensure the conservation of forest-dependent plant and animal species.
   - Forests can help combat climate change.
   - Many people depend on forests for at least part of their livelihoods and for basic needs such as food and medicines.
5. After ten minutes, stop the game, read the above five answers, and ask the pupils to write them in their exercise books.

2 Activity 2: Create your own Möbius strip

indoor This activity should take **25 minutes**.

1. Organize the pupils into groups of eight to ten.
2. Give each group a strip of paper. The glue will need to be shared among the groups.
3. Ask the pupils to sketch a forest on one side of the paper strip. Remind them of the various elements in a forest ecosystem (e.g. trees, bushes, animals and flowers). Also point out that we use the forest in many ways (Figure 5.4).

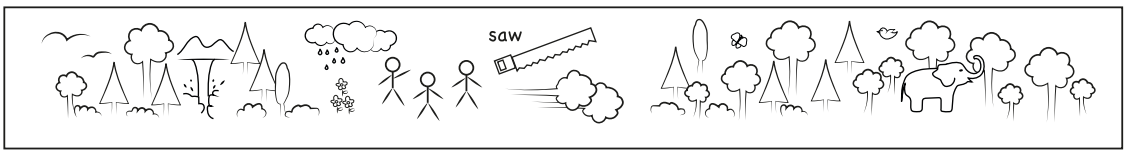


Figure 5.4. Sustainable forest management

4. On the other side of the strip, the pupils should write "Sustainable forestry", as shown in Figure 5.5.

SUSTAINABLE FORESTRY SUSTAINABLE FORESTRY SUSTAINABLE FORESTRY

Figure 5.5. Sustainable forest management

5. Tell the groups that they now need to glue the two ends of their strips together to form an infinity ring (see Figure 5.6). Show the pupils the infinity ring you have already made, to give them an idea of how to do it.

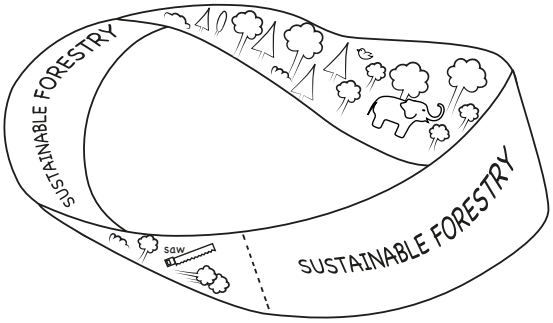


Figure 5.6. The sustainable forestry infinity ring

6. Ask the pupils whether they can guess what their infinity rings have to do with forest sustainability and what they symbolize. Allow the pupils time to think and then invite some to share their ideas.
7. Then **explain:** The infinity ring stands for the never-ending functioning of sustainable forest management! Sustainable forestry makes it possible to use forests and conserve them – and all the roles they perform. Sustainably managed forests will be available for future generations, too.

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Preparation for the next lesson

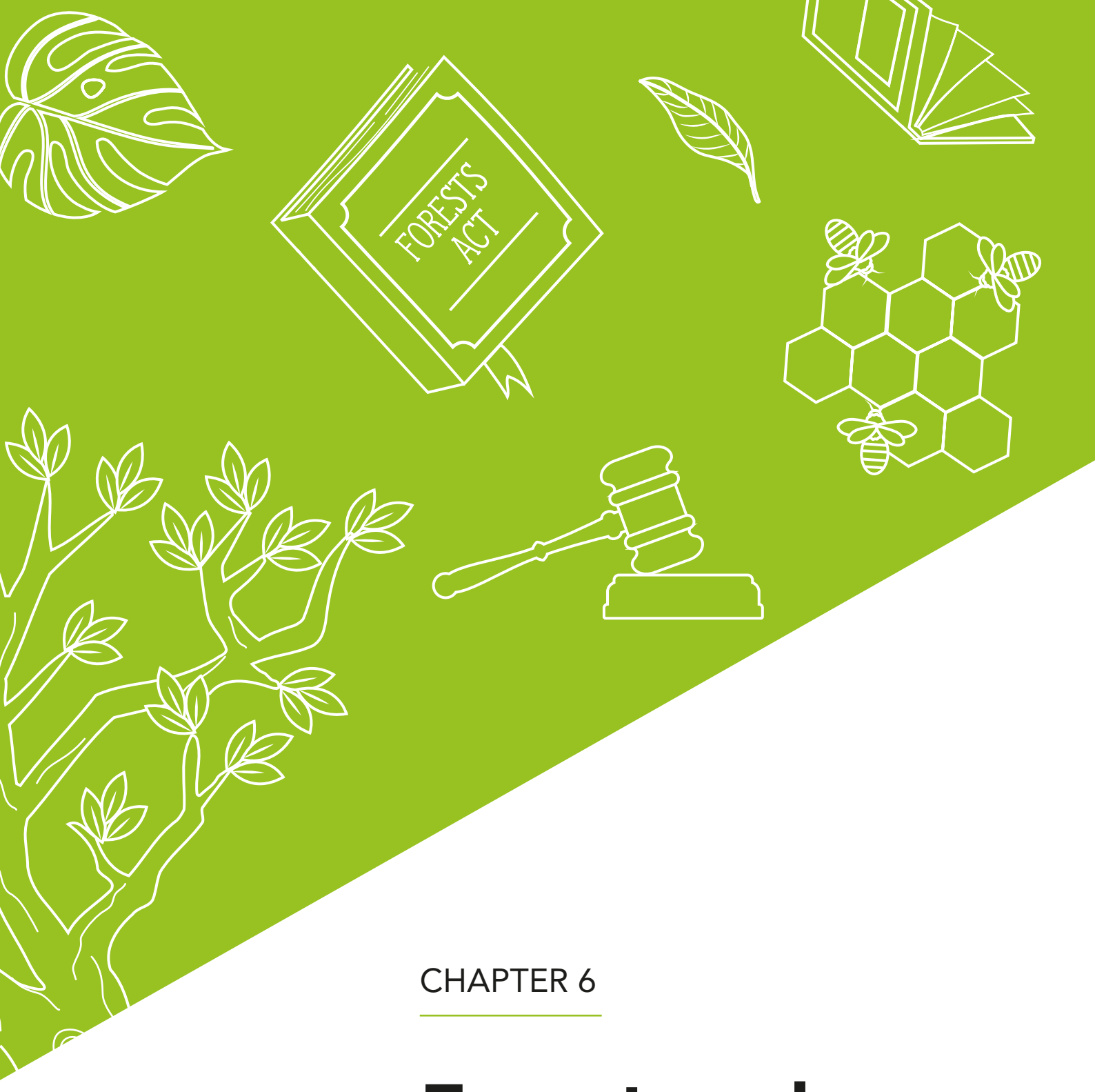
Tell the pupils to think about why we need laws. Suggest that they talk about this with their families. Ask them to write their ideas in their exercise books.

Notes

[1] **FAO.** 2020. *Global Forest Resources Assessment 2020 – Main report.* Rome. https://doi.org/10.4060/ca9825en

[2] **FAO.** 2020. *Global Forest Resources Assessment 2020 – Main report.* Rome. https://doi.org/10.4060/ca9825en

[3] **FAO.** 2020. *Global Forest Resources Assessment 2020 – Main report.* Rome. https://doi.org/10.4060/ca9825en



CHAPTER 6

Forest and beekeeping laws

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Overview

In this chapter, the pupils will learn why policies and laws are needed to protect forests and encourage their sustainable management and use. They will learn about forest and beekeeping laws in the United Republic of Tanzania by creating a mind map, playing outdoor games and getting involved in a discussion to deepen their learning.

Objectives

By the end of the chapter, the pupils will be able to:

- explain the concepts behind the forest and beekeeping laws of the United Republic of Tanzania;
- understand the main forest and beekeeping laws in the United Republic of Tanzania; and
- explain why these laws are important.

Background information

Why do we need laws to protect our forests?

Laws ("Acts") regulate the social behaviour of people and determine what the inhabitants of a legal jurisdiction (such as a country) may and may not do. Good laws protect people from the consequences of unlawful activities.

Given the many competing interests in forests, laws are needed to conserve forest biodiversity, help mitigate climate change and safeguard the livelihoods of people who depend on forests. People need forests for timber, woodfuel, food and the many services they provide. If people could go into a forest and take whatever they wanted, it is likely that the forest would soon become depleted and ultimately be destroyed.

Forest laws contain rules for managing forests to enable their sustainable use and the fair distribution of forest benefits. Beekeeping laws set out the rules for trading bee products, managing bee resources and protecting bee habitats, including forests.

Laws can protect forests in various ways, from designating how tree harvesting must be carried out to prohibiting or restricting tree-felling and the use of other forest resources (such as wildlife). Forest laws regulate forest use so that forest values are maintained and the benefits distributed fairly. Forest laws also deter criminals from stealing and otherwise misusing forest resources. Criminal forest-related activities include illegal logging (illegally taking wood from a forest), the illegal occupation of forest lands and the illegal trade of forest resources.

What are the purposes of forest and beekeeping laws?

The purposes of forest and beekeeping laws include the following:

- **The sustainable management of forest resources.** For example, laws may stipulate the need to ensure that no more wood is harvested than can grow back before the next harvest and also require that any timber harvesting is conducted legally.
- **Forest conservation.** For example, laws may designate areas where timber harvesting is not permitted and areas where timber harvesting (and hunting) is allowed under certain conditions. They may also specify other measures to protect biodiversity.
- **Trade in forest products.** For example, a law may require that the sale of forest products is accompanied by certain licences, permits or certificates to prevent the trade of illegally harvested products.
- **Sustainable management of bee resources and trade of their products.** For example, a law may be enacted to ensure that beekeeping is sustainable and that products from beekeeping comply with local and international standards.
- **Forest use, protection and management in villages.** For example, village-level laws may set out the rights and responsibilities of villagers in protecting and managing their forests.

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Picture 6.1. Signs calling for a responsible use of the forest in the Uluguru Nature Forest Reserve

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Picture 6.2. Beekeeping in a forest

How important are forest and beekeeping laws in the United Republic of Tanzania?

In the United Republic of Tanzania, people need a permit to enter a forest reserve[i] and to cut down trees inside a forest reserve[i] or take other forest products from it. Permits are also required to operate sawmills and other industrial machinery and construct roads, bridges, paths, railways and buildings. People lacking permits may not harvest or gather forest products such as timber, medicinal herbs and other plants and non-timber forest products for sale. No one may export timber or other forest products without a valid export licence.

Trees may not be felled in national parks. In private forests, owners must inform the authorities before undertaking operations and conform to their recommendations; the authorities will advise how to sustainably manage the resource and ensure that adequate support is available.

[i] A forest reserve is a forest area recognized and demarcated for production of timber and other forest products or for water catchment and biodiversity conservation, under the Forest Act.

Laws and regulations in place in the United Republic of Tanzania to protect forests and beekeeping include the following:

- The Forest Act (2002) sets out the management and conservation of forest resources and regulates the trade of forest products.
- The Beekeeping Act (2002) is designed to enhance the beekeeping sector's contributions to sustainable development and the conservation of natural resources for the benefit of present and future generations. In particular, it aims to conserve biodiversity and ensure sustainable populations of honeybees by creating and maintaining bee reserves and apiaries. Another aim of the act is to increase employment and trade in the beekeeping sector and thereby its contributions to poverty alleviation.
- The Forest Regulations (2004), the Forest (Amendments) Regulations (2017), the Beekeeping (General) Regulations (2005), the Beekeeping (General) (Amendment) Regulations (2019), the Forest (Sustainable Utilization of Logs, Timber, Withies, Poles or Charcoal) Regulations (2019) and the Forestry (Amendment) Regulations (2020) define the roles and responsibilities of government agencies, companies and individuals in forests and beekeeping and the rights granted over the management and use of forests and other natural resources.

The implementation of this legislation is supported by other acts, such as the Land Act (1999) and the Village Land Act (1999).

About 34 percent of the total land area of the United Republic of Tanzania has been designated as forest reserves and wildlife protected areas (the latter includes national parks, game reserves and designated wetlands), exceeding the international target of 17 percent.[1]

Breaking forest laws in the United Republic of Tanzania may incur penalties such as fines and even imprisonment.

Picture 6.3. Serengeti National Park

Picture 6.4. Mikumi National Park behaviour instructions

LESSON 18

Why do we need forest laws?

18

1 Activity 1: Brainstorm on the importance of rules

This activity should take **15 minutes**.

1. Start the lesson by asking the pupils to think of some school rules.
2. Invite a volunteer to describe a school rule.
3. Ask why this rule exists and invite another pupil to answer.
4. Explain that laws in society are like the rules at school. Ask the pupils: "Why do we need laws? What would happen if everyone in the United Republic of Tanzania could do whatever they wanted without consequences?"
5. Invite a few pupils to share their thoughts.
6. The following examples could be used to complement the pupils' answers:
   - » If there were no traffic rules, there would be more road accidents.
   - » If there were no laws about theft, people might take things from shops without paying.
   - » Without forest laws, people could use forest resources unsustainably. For example, people could cut down too many trees and end up destroying the forest. This would mean that, in the future, other people could not use the forest to gather food and medicines and earn their livelihoods. The forest would be unable to provide its many benefits.
7. **Explain:** Without rules and laws, there would be chaos. It would be hard for large groups of people to live harmoniously together because not everyone would spontaneously treat other people, nature and objects responsibly.

2 Activity 2: Learn about the purpose of forest and beekeeping laws

This activity should take **25 minutes**.

1. **Explain:** There are laws to protect forests in the United Republic of Tanzania. Forest laws regulate the use that people make of forests, such as the harvesting of timber, woodfuel and other forest products. Forest laws help ensure the long-term conservation of forests and the many roles that they play in our lives.

2. Write in the middle of the board:
   - What are the purposes of forest laws?
3. Around this, create a Figure (Figure 6.1), step by step.
4. First, copy the titles in bold below onto the board. After writing each title, discuss the associated examples with the pupils and note these on the Figure in a few words. Ask the pupils to copy the titles and examples on the board into their exercise books. Proceed in this way until the Figure is complete.

   The purposes of forest and beekeeping laws:

   - **Sustainable management of forest resources.** For example, laws may stipulate the need to ensure that no more wood is harvested than can grow back before the next harvest and require that any timber harvesting is conducted legally.
   - **Forest conservation.** For example, laws may designate protected areas where timber harvesting is not permitted and forest areas where timber harvesting (and hunting) is allowed under certain conditions, and they may specify additional measures to protect wildlife and other biodiversity.
   - **Trade in forest products.** For example, a law may require that the sale of forest products is accompanied by certain licences, permits or certificates to prevent illegal trade. Some people cut down and sell valuable trees without permission. This is illegal logging and illegal trade.
   - **Sustainable management of bee resources and trade of their products.** For example, a law may be put in place to ensure that beekeeping is sustainable and that products from beekeeping comply with local and international standards.
   - **Forest use, protection and management in villages.** For example, village laws may set out the rights and responsibilities of villagers in protecting and managing their forests.

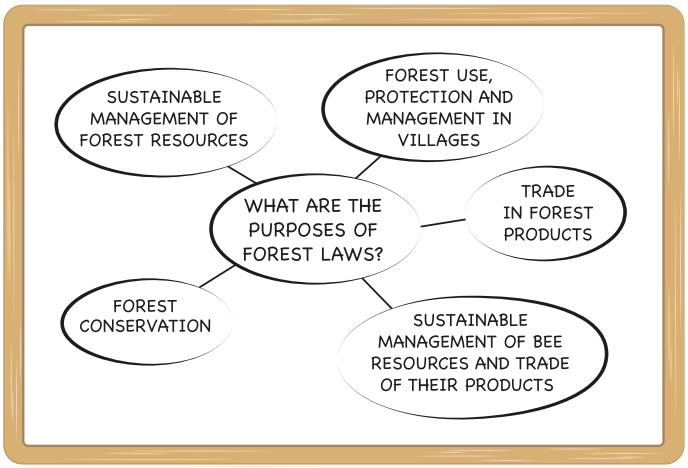


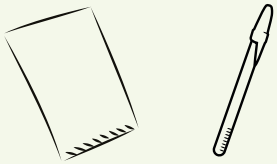
Figure 6.1. Purposes of forest and beekeeping laws

LESSON 19

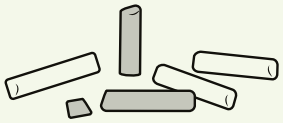
Allowed or not?

19

Required materials



1 PEN, 1 SHEET OF PAPER



CHALK

Preparation for the lesson

Before the start of the class, prepare a playing field in the schoolyard. Use the chalk to mark out three lines, each about 15 m (metres) long (or longer, if necessary) and about 10 m apart (see Figure 6.2).

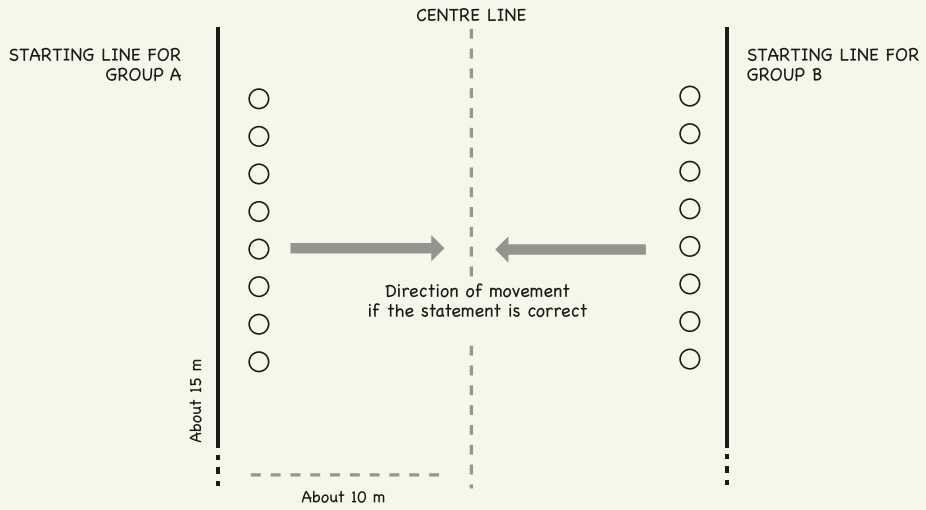


Figure 6.2. A game about forest laws

1 Activity 1: Understand what is permitted in a forest

outdoor This activity should take **30 minutes**.

1. Explain to the pupils that they will play a game about what people are, and are not, allowed to do in forests in the United Republic of Tanzania.
2. Organize the class into two groups of equal size (group A and group B). When group A plays the game, group B will observe and take notes. The groups will swap roles later.
3. Divide group A (the "players") into two subgroups of equal size and instruct each of these to line up along one of the starting lines, opposite the other subgroup. The line in the middle will be free.
4. **Explain:**
   - » You will read out statements (for example: "You need a permit to hunt in the forest.")
   - » Players who think a statement is true will rush towards the centre line.
   - » Players who think a statement is false will stay where they are.
   - » You will then tell the pupils the correct answer.
   - » The game will keep going while you read out additional statements.
5. The group of observers (i.e. group B) should choose a secretary, who will write down what is allowed and what is not allowed in forests in the United Republic of Tanzania. For each statement, the secretary will write down how many pupils (from both subgroups) chose the correct answer (i.e. true or false).
6. Halfway through the list of statements, ask group A and group B to swap roles. Thus, the players will become the observers and the observers will become the players.
7. Play the game as before, with the roles swapped. The new group of observers (group A) should also choose a secretary to write down what is, and is not, allowed in forests in the United Republic of Tanzania. For each statement, the secretary will write down how many pupils (from both subgroups) chose correctly whether it was true or false.
8. These are the statements:
   - » Anyone can walk in a forest as long as it isn't a forest reserve (TRUE).
   - » You do not need a permit to camp in the forest (FALSE).
   - » You need a permit to operate a lodge (TRUE).
   - » You need a permit to cut down trees (TRUE).
   - » You do not need a permit to hunt wild animals (FALSE).

   [Swap the two groups here.]

   - » You need a permit to fish in the river as a business (TRUE).
   - » If you break a forest law in the United Republic of Tanzania, you could be fined or even imprisoned (TRUE).
   - » You can practise beekeeping in a forest reserve without a permit (FALSE).
   - » Anyone can burn vegetation near their house (FALSE).

2 Activity 2: Recap what you learned

This activity should take **10 minutes**.

1. Ask the pupils to form a circle.
2. Ask the secretary of group A, and then the secretary of group B, to read from their notes on what is and is not allowed in Tanzanian forests. Ask them to also tell the class how many pupils guessed correctly whether the statements were true or false.
3. If most of the pupils guessed correctly, congratulate them and encourage them to share their knowledge with their friends and family.
4. If most of the pupils did not guess correctly, reassure them by saying that many laws and regulations apply in forests, and learning them takes time. Now they know some of the rules for using and conserving forests in the United Republic of Tanzania.

LESSON 20

Play a forest law guessing game 20

1 Activity 1: Describe what is permitted in a forest

indoor

This activity should take **25 minutes**.

1. Tell the pupils that they will play a guessing game in which you will read out statements about what is allowed and what is not allowed in forests in the United Republic of Tanzania, and the pupils will vote on whether the statements are true or false. Pupils should raise two hands if they think a statement is true and one hand if they think it is false.
2. Draw two columns on the board. The first should be titled "Anyone can….", and the second column should be titled "Permission/permit required".
3. Read out the statements below, one at a time, and ask the pupils to vote.
    - Anyone can **burn vegetation near** their **house** (FALSE).
    - You need permission to **take a plant from a forest reserve for medicine** (TRUE).
    - Anyone can **walk in forest, as long as it isn't a forest reserve** (TRUE).
    - You do not need a permit to **hunt wild animals** (FALSE).
    - Everyone is allowed to **grow trees, crops and vegetables on their lands** (TRUE).
    - You do not need a permit to **camp in a forest** (FALSE).
    - You need a permit to **operate a lodge in a forest** (TRUE).
    - Anyone may **graze** their **domestic animals in a forest** (FALSE).
    - You need a permit to **cut down or remove a tree in a reserved forest** (TRUE).
    - You do not need a permit to **enter a forest reserve** (FALSE).
    - Anyone can **collect herbs for** their **family's use**, but **not in a forest reserve** (TRUE).
    - You need a permit to **fish in a river as a business** (TRUE).
    - You need a permit to **practise beekeeping in a forest reserve** (TRUE).
4. After the pupils have voted for a statement, reveal the correct answer and write the text in bold type under the correct column on the board (Figure 6.3).

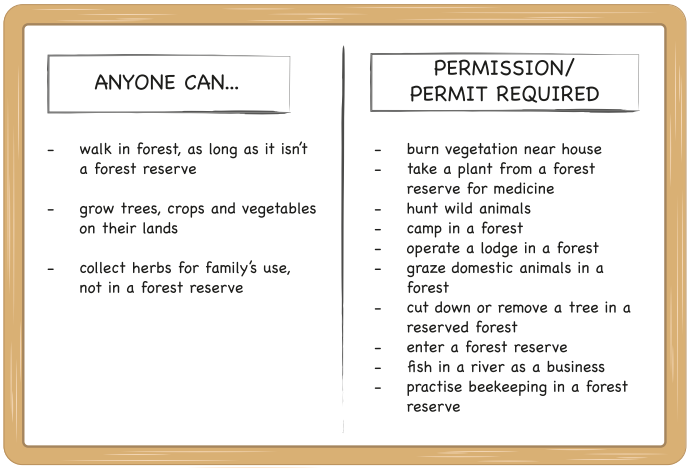


Figure 6.3. What is permitted in a forest

5. Repeat with the next statement and continue until you have finished all the statements and completed both columns on the board.
6. Ask the pupils to copy the two columns, with the correct answers, into their exercise books.

2 Activity 2: Reflect on what you have learned

indoor

This activity should take **15 minutes**.

1. Ask the pupils to recall why it is essential to have laws in general and forest laws in particular.
2. Invite some pupils to answer, ensuring that a range of answers is given. Correct any incorrect answers.
3. Copy the following question and answer on the board.

   ► What is the objective of forest laws?

   Answer: To sustainably manage forests and their resources and to protect and conserve them for future generations.

4. Ask the pupils to copy this question and answer into their exercise books.

Preparation for the next lesson

Tell the pupils to ask their parents, grandparents, relatives or neighbours the following question:

- What do you think a forester does?

Notes

[1] **Government of the United Republic of Tanzania.** 2014. *Fifth National Report on the Implementation of the Convention on Biological Diversity.* Dar es Salaam, Vice President's Office, Division of Environment. www.cbd.int/doc/world/tz/tz-nr-05-en.pdf

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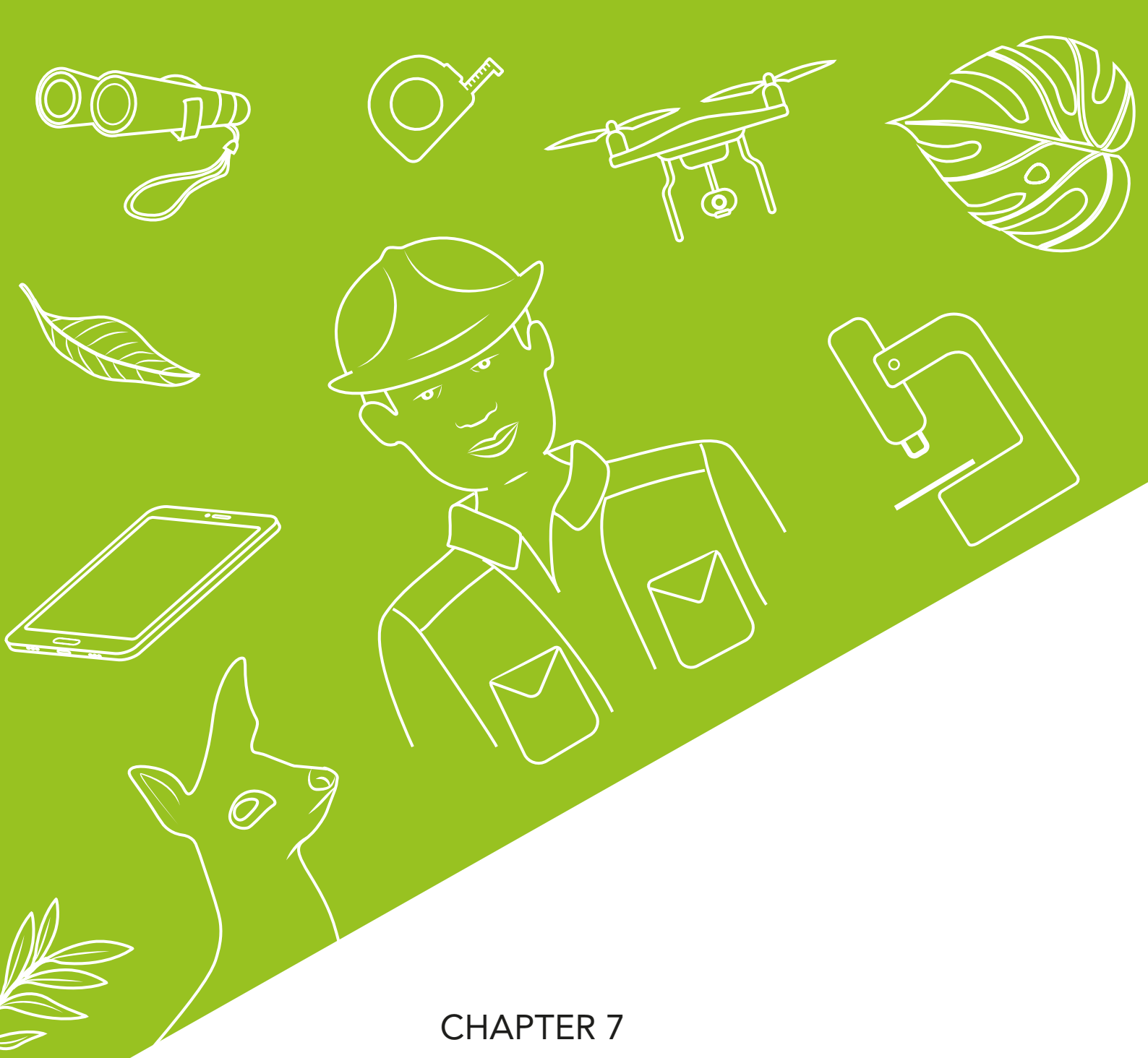

CHAPTER 7

The work of a forester

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Overview

In this chapter, the pupils will learn about forestry as a profession and the various tasks it involves. They will explore the roles of foresters through discussion and a mime game, assess various forest uses in an outdoor game, and deepen their knowledge of the forestry profession through reflection.

Objectives

By the end of the chapter, the pupils will be able to:

- understand what a forester does and describe the tasks of a Tanzanian forester;
- discuss why the forestry profession is important for forests, people and the planet; and
- explain how foresters are trained in the United Republic of Tanzania.

Background information

What does a forester do?

A forester is a person who practises forestry, which is the profession of managing and protecting forests.

Foresters have many roles. They are responsible for looking after trees and forests, planting new trees, keeping track of which trees – and how many trees – are harvested, managing protected forests, and preventing illegal logging and wildfires, among other responsibilities.

Foresters in the United Republic of Tanzania perform many tasks, such as:

- advising communities on when, where and how many trees may be sustainably and legally harvested;
- assessing the risk of forest wildfires and working to prevent them;
- supervising forest patrols to ensure that nearby communities are safe from wildfires and wildlife and that wildlife is safe from poachers;
- helping communities and individuals use their forests sustainably;
- supervising tree-pruning in cities and around buildings so that trees are well cared for, thereby minimizing the risk that falling branches will damage property and harm people;
- monitoring forests, measuring trees and working with researchers to keep track of changes in the forests of the United Republic of Tanzania and help maintain forest health and productivity;
- encouraging and helping local communities to plant trees and conserve forests to ensure that future generations may also benefit from trees and forests; and
- advising governments, individuals and the private sector on investments for producing and selling forest products.

Why are foresters important for forests and the environment?

Foresters ensure that forest management is sustainable – so that people do not cut down more trees than can grow back before the next harvest (see Chapter 5). All foresters worldwide are responsible for ensuring that forests stay healthy and productive and therefore can continue benefiting people into the future.

Foresters working in villages support local communities in managing their forests. They help ensure that everyone benefits from forests and the revenues they generate and that people follow forest laws and regulations. At the national, zonal, regional and district levels, foresters in the United Republic of Tanzania work as technical officers to coordinate the implementation of forest policies, laws, regulations and programmes.

Picture 7.1. Confiscated poachers' rifles, snares and shotgun shells

Picture 7.2. Rangers surveying the landscape

How do you become a forester, and what other professions are related to forestry?

Forestry is an important profession. In the United Republic of Tanzania, forestry students may undertake various levels of formal training in qualified institutions, such as certificates, diplomas and degrees (bachelors, masters and doctorates). A passion for nature and forests is important if you want to be a forester.

Careers that involve substantial time in forests

Various professions involve spending substantial time in forests, such as the following:

- **Foresters** care for, plant and manage trees and forests. They may be involved in forest restoration, which improves the health of the forest; conservation, which protects forests; the harvesting of forest products, which generates income and employment; and managing protected forest areas.
- **Forest ecologists** study the ways in which forest species interact with the environment. Ecologists are often involved in environmental conservation.
- **Arborists** – also called tree surgeons – maintain trees, plant new trees and even move trees as part of ensuring that trees are healthy and that forests are well managed. They work mostly in cities.
- **Forest health specialists** focus on protecting forests from pests and diseases, which, if unchecked, could harm and even kill individual trees and damage large areas of forest.

- **Forest researchers and scientists** work in universities and research institutions in diverse fields, such as biology, genetics, chemistry, pathology, engineering, mechanization, computer science, remote sensing, economics and policy.
- **Conservation officers** protect forests and wildlife. Conservation officers have a wide range of duties – they are responsible for preparing management plans and providing guidelines on how to properly manage forests and their products.
- **Rangers** patrol forests to prevent illegal logging, poaching and other misuse. Professionals in this category must be brave because they may be required to confront poachers and illegal loggers, which can be dangerous. Rangers also prevent and help fight forest wildfires – they are knowledgeable about the risks of forest wildfires and have the skills to prevent them by, for example, cutting firebreaks (gaps in vegetation) to stop or slow fires, planting fire-resistant trees, and conducting controlled fires to reduce fuel loads. They also know the best ways to fight wildfires. Rangers help keep forest visitors safe by maintaining trails and other infrastructure.

Forest industry careers

Other forest-related jobs may require technical knowledge in engineering or skills in advanced computer technologies. A geographic information system specialist, for example, creates digital maps of forests to help forest planning and management. Other professions may involve the physical process of felling trees and handling forest logs, driving logging trucks and operating sawmills.

Picture 7.3. A forest officer measuring a tree

Picture 7.4. A forest researcher working in a laboratory

Picture 7.5. A conservation officer inspecting pine tree seedlings at a nursery

Picture 7.6. A worker for the Tanzanian Forest Service grafting tree seedlings

Picture 7.7. A worker controlling the machines operating in a sawmill

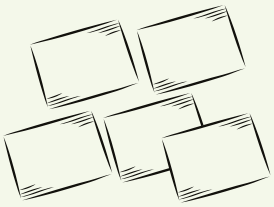
Picture 7.8. A worker cutting off a pine in a plantation

LESSON 21

What does a forester do?

21

Required materials



5 MANILA CARDS
OR A SHEET OF A4 PAPER
CUT INTO 5 PIECES

Preparation for the lesson

On manila cards or sheets of paper, write the following five tasks of a forester (one task per card) and suggestions for miming them:

1. **Protect nature and forests** (mime suggestions: walking through a forest with binoculars; controlling a drone flying over a forest).
2. **Make sure that forests are managed sustainably** – take no more wood than can grow back before the next harvest (mime suggestions: counting or measuring trees; planting trees).
3. **Fight fires** (mime suggestion: extinguishing a fire).
4. **Supervise wood harvesting** (mime suggestions: stamping papers; inspecting a logging site; counting logs on a log truck).
5. **Provide support and advice on managing forests** (mime suggestions: reading graphs or books; working on a computer; giving a lecture; guiding people in a forest).

1 Activity 1: Make a mind map on the tasks of a forester

This activity should take **20 minutes**.

1. Write "Tasks of a forester" in the middle of the board (Figure 7.1).

2. Then ask the pupils:
   - Can you name some tasks of a forester?
   - What did you find out from your family, friends and neighbours?
3. Write some of the pupils' answers on the board to create a mind map around "Tasks of a forester". Make sure that the answers reflect different work areas.

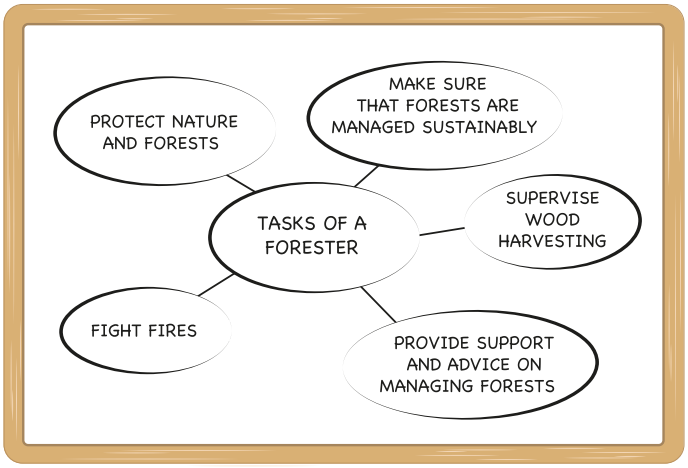


Figure 7.1. Tasks of a forester

4. Ask the pupils to copy the mind map into their exercise books.
5. If time allows, deepen the discussion by adding that, in addition to foresters, there are many other types of forest-related jobs. Refer to the list of forest-related professions in the background information.

2 Activity 2: Mime the tasks of a forester

indoor This activity should take **20 minutes**.

1. Explain that, in this activity, selected pupils will mime some of a forester's tasks and the rest of the class will try to guess the tasks.
2. Ask for volunteers to do the mimes.
3. Form five groups of two to three volunteers each and call them to the front of the classroom.
4. Give each group a card showing a task of a forester and suggestions for miming it.

Important: Distribute the cards so that no one else can see the forester's tasks written on them. Ask the selected pupils or small groups to keep their tasks secret.

5. Encourage the mimers to think how they can mime their forester's task using gestures, with no speaking.
6. During this time, ask the rest of the class to think about specific actions that a forester might do for each of the tasks on the mind map and write them down, if possible. For example, protecting nature and wildlife might involve walking through the forest and looking for animals with binoculars or chasing poachers. In this way, the pupils will stay on-topic, and there will be minimal noise while the volunteers are planning their mimes.
7. Ask the mimers one by one to perform their mimes for a maximum of about a minute. If several pupils are to mime the same task in a small group, it is fine for each pupil to choose their own way of presenting it.
8. Ask the rest of the pupils to name the action being performed (e.g. sawing wood, reading a book, working on a computer, putting out a fire or flying a drone).

> **Tip:** Ask the class to watch calmly and to put their fingers on their noses as soon as they think they have the answer. This will ensure that they do not shout out their answers. When most of the pupils have their fingers on their noses, choose one to give their answer. If the answer is incorrect, ask another pupil and so on until someone guesses correctly.

9. The class should then try to guess the forester's task from the mind map on the board.

Preparation for the next lesson

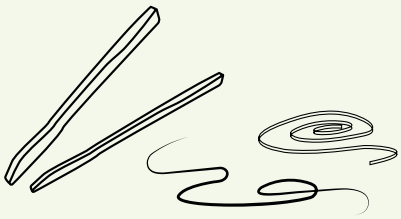
Ask the pupils to each bring a cap, handkerchief or piece of cloth to the next lesson. These will serve as team markers in the forest resources game. As another option, bring these items in yourself.

LESSON 22

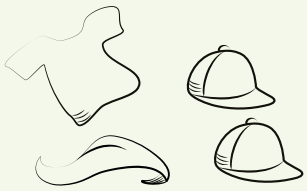
What happens when we overuse forest resources?

22

Required materials



STICKS AND RIBBONS
OR STRING
to mark the playing field



TEAM MARKERS, SUCH AS CAPS,
HANDKERCHIEVES
OR PIECES OF CLOTH

Preparation for the lesson

In the schoolyard, before the lesson, mark out a square playing field roughly 40 m × 40 m (metres) in size. Mark the corners clearly with sticks and, if necessary, ribbons (Figure 7.2).

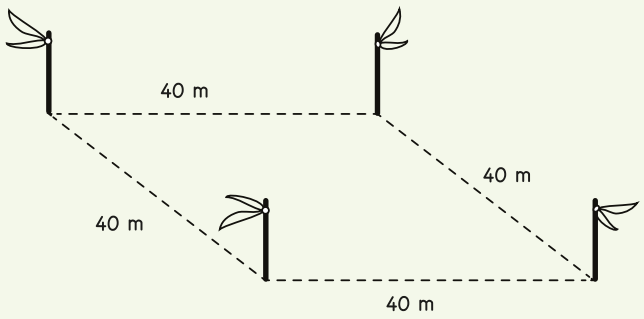


Figure 7.2. The forest resources playing field

1 Activity 1: Understand the implications of overusing forest resources

outdoor This activity should take **40 minutes**.

1. Explain that the game will be about consuming forest resources (such as wood, food and medicines).
2. Choose one pupil to represent a human being who uses forest resources.
3. Choose 40 pupils to represent forest resources such as wood, food and medicines. Each of these 40 pupils will wear a team marker such as a cap or a handkerchief, or tie a piece of cloth to their wrists.
4. Ask the rest of the pupils to observe. They will be asked later to put on their team markers and join the game.
5. Blow a whistle or clap your hands to start the game.
6. Explain the rules of the game:
   - People improve their standard of living when they obtain forest resources such as wood, food and medicines. The pupil representing the human will try to tag ("catch") as many of the pupils representing forest resources as possible. (If it is necessary to avoid physical contact between pupils, the pupil representing the human should instead try to tag the pupils representing forest resources by stepping on their shadows and calling out their names.)
   - The "forest resources" run away so that they are not too easy to catch.
   - When they are caught, the "forest resources" must remove their team markers and become "human". They may then join in and start catching forest resources.
   - Nature is constantly renewing itself by growing trees and plants. These are represented by other pupils coming onto the field. As the game continues, ask two observer pupils at a time to put on their team markers (to show that they are forest resources) and enter the playing field.
7. Continue the game until all the forest resources are used up (i.e. all the pupils have been caught).
8. When the game ends, ask the pupils to reflect on how the people consumed all the forest resources. Eventually, no more forest resources were available (when all the pupils were inside the playing field and had become tagged as humans). The pupils will discuss this further in the next lesson.

LESSON 23

How do you become a forester? 23

1 Activity 1: Discuss the importance of forest management

This activity should take **15 minutes**.

1. At the beginning of the lesson, ask the pupils to recall the forest resources game from the previous lesson.
2. Ask them the following questions to lead the discussion. Invite a few pupils to give their answers and then provide the correct answers, if necessary.
   - Why did the "human" want to catch the "forest resources" (those pupils wearing caps, handkerchiefs or pieces of cloth)?
   - » **Answer:** Forest resources such as wood, food and medicines are important for many livelihoods.
   - What happened when more forest resources were caught and became humans?
   - » **Answer:** There were more people and fewer forest resources.
   - At the end of the game, there were only humans and no forest resources. What does this mean?
   - » **Answer:** Using more forest resources than can grow back before the next harvest eventually depletes the forests and can destroy them.
   - The forest resources were able to regenerate (by bringing new pupils into the playing field). How can we benefit from this without destroying forests?
   - » **Answer:** It is important to manage forests sustainably, never taking more than can grow back before the next harvest.
3. Direct the conversation to the tasks of a forester discussed in the first lesson. Ask them:
   - Who can help prevent the overuse of forest resources?
   - » **Answer:** Foresters can! Foresters know how to manage forests sustainably, and they allow people to only use as many resources as will grow back before the next harvest. Foresters make sure that we use forests without destroying them.
4. Write the answer on the board and ask the pupils to copy it into their exercise books.

2 Activity 2: Understand how to become a forester

This activity should take **5 minutes**.

1. Ask the pupils:
   - How do you become a forester?
2. Invite some pupils to share their ideas.
3. Then **explain:**
   - Foresters have a great responsibility because forests and nature are the basis of life for people, as well as for forest plants and animals.
   - Forestry is a recognized profession around the world. You need a good education to be a forester.
   - Forestry is a recognized profession with specific training in the United Republic of Tanzania. For example, you can become a forester by studying at the Forestry Training Institute, Olmotonyi, in Arusha. There are forestry programmes in many universities around the world. In the United Republic of Tanzania, the Sokoine University of Agriculture and other universities offer forestry programmes.
4. Write the names and locations of the Tanzanian forest training centres on the board.

3 Activity 3: Explore other forest-related professions

This activity should take **20 minutes**.

1. Explain to the pupils that there are many other forest-related professions.
2. One by one, read out the following list of jobs:
   a. Ranger
   b. Baker
   c. Firefighter
   d. Street cleaner
   e. Conservation officer
   f. Log-truck driver
   g. Eye doctor
   h. Geographic information system specialist
3. For each job, ask those pupils who think it has something to do with forests to stand up (those who think the job has nothing to do with forests should remain seated).
4. Then, give the correct answer.

a. Ranger (YES – they help keep park visitors safe by maintaining trails; they prevent illegal logging and wildlife poaching; they work to prevent forest wildfires; and, if a fire starts, they know how to fight it.)

b. Baker (NO)

c. Street cleaner (NO)

d. Conservation officer (YES – their job is to protect forests and wildlife.)

e. Log-truck driver (YES – they transport logs from the forest to the sawmill.)

f. Eye doctor (NO)

g. Geographic information system specialist (YES – a geographic information system specialist creates digital maps of forests that help in planning and managing forests.)

5. If time allows, discuss what is involved in the various forest-related professions and answer the pupils' questions about them.
6. Ask the pupils to write the forest-related jobs in their exercise books.

Alternative approach to the lesson

If you know a forester, invite them to talk to the pupils about their education and the work they do. Discuss the visit with the pupils in advance and encourage them to think of questions to ask the forester.

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Preparation for the next lesson

Ask the pupils to reflect on what they have already learned about weather, climate and forests. Ask them to consider the following questions:

- What is the human-induced greenhouse effect?
- What does the human-induced greenhouse effect have to do with climate change?
- How can forests help protect us from the impacts of climate change?

CHAPTER 8

Forests and climate change

What we can do

Overview

In this chapter, the pupils will apply what they have learned about forests and the importance of managing them sustainably. They will learn how they can help protect forests, how best to inform people about the need to protect forests, how to motivate others to contribute to forest protection, and how to help communities adapt to the impacts of climate change.

Objectives

By the end of the chapter, the pupils will be able to:

- explain the significance of the human-induced greenhouse effect;
- describe the importance of forests as a way of combating climate change;
- develop ideas on how to protect forests and mitigate climate change; and
- understand ways of raising public awareness about the importance of forests.

Background information

Important: This chapter is not intended to introduce new concepts. Its purpose is to review and reinforce what the pupils have learned in Module 3 and to stimulate their thinking on how they might help combat climate change and protect forests in their daily lives.

What is the greenhouse effect and what does it have to do with climate change?

The greenhouse effect is a natural phenomenon caused by greenhouse gases such as carbon dioxide and methane in the atmosphere, which trap heat and cause the Earth's surface to warm up.

Some of the sun's rays that pass through the atmosphere are absorbed by the Earth's surface, which warms up, and others are reflected back as heat. Much of this reflected heat disappears into space, but some is trapped by greenhouse gases naturally present in the atmosphere, further warming the Earth.

Because of the natural greenhouse effect, the Earth is 33 °C warmer than it would be without it.[1] Without the natural greenhouse effect, life as we know it would not exist because the planet would be too cold. But human activities are increasing the concentration of greenhouse gases in the atmosphere, causing the Earth to warm up more. This is resulting in major changes in climate, with the potential to negatively affect food production, water availability, the habitability of certain regions and biodiversity, among other impacts.

How do human activities contribute to the greenhouse effect?

Since 1800, the concentration of carbon dioxide in the atmosphere has increased by nearly one-third (30 percent) because of human activities. The consequent global warming is called the anthropogenic (human-induced) greenhouse effect and is responsible for climate change.

Activities such as driving our cars, cooking our meals, manufacturing and transporting our goods and heating and cooling our homes are causing the emission of huge volumes of carbon dioxide and other greenhouse gases. This is largely because they involve the burning of fossil fuels such as coal, oil and gas.

The clearing and burning of forests also contribute to the greenhouse effect because they release carbon dioxide and other greenhouse gases. Once removed, forests are unable to perform their function of capturing carbon dioxide from the atmosphere.

Raising livestock, especially cattle and pigs, causes large emissions of methane, which is a potent greenhouse gas.

Picture 8.1. Traffic in Arusha

Picture 8.2. A factory emitting smoke and other pollution

How can forests help combat climate change?

Forests and trees make important contributions to protecting the Earth's climate. Trees absorb carbon dioxide through photosynthesis and store it as carbon in their wood. When trees are cut down to make wood products like furniture and timber for construction, the carbon stays locked inside these products, potentially for hundreds of years.[2] If the wood is used for energy purposes, the carbon stored will be released when the wood is burnt.

Increasing the use of wood in construction and in products such as furniture, cabinets, flooring, doors and window frames can help reduce greenhouse gas emissions. For example, fewer greenhouse gases are emitted when wood is used instead of less climate-friendly materials such as concrete, metal, bricks and plastics, the production, use and disposal of which emit much larger amounts of greenhouse gases.

Forests and trees influence local weather. Trees provide shade, reducing the temperature underneath. They also absorb water from the soil through their roots and release it into the air through their leaves (transpiration). The water absorbs heat as it transforms from liquid to vapour, thus cooling the air. This cooling effect of trees and forests is measurable in towns, villages and cities. If well planned and managed, trees in cities can cool the air by 2–8 °C. In large forest areas such as the Congo Basin, the huge volume of water that the forest circulates can affect the climate, not just locally but across vast regions and even globally.

Deforestation can have negative impacts on the climate. When forests are lost, they can no longer absorb carbon dioxide from the air and thus cannot help combat climate change. When trees die and decompose or when they burn, the carbon that they stored is released into the air as greenhouse gases, contributing to global warming (see Chapter 2 and Chapter 3).

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Picture 8.3. Oasis in the Serengeti

LESSON 24

Why do forests matter for climate change?

24

Preparation for the lesson

- Write a big question mark in the middle of the board (Figure 8.1).
- Write the terms shown below (in bold) in large letters on the board in random order around the question mark.
  - **High carbon dioxide emissions** (due to burning too much fossil fuel, destroying forests, etc.)
  - **Human-induced greenhouse effect**
  - **Global warming**
  - **Climate change**
  - **Unsustainable forest management**
  - **Destruction of livelihoods**
  - **Lower carbon dioxide emissions** (due to sustainable lifestyles and actions, such as managing forests sustainably)
  - **Sustainable forest management**
  - **Forests as carbon stores**
  - **Stable climate**
  - **Forests as a source of sustainable livelihoods**
  - **A sustainable future for all**

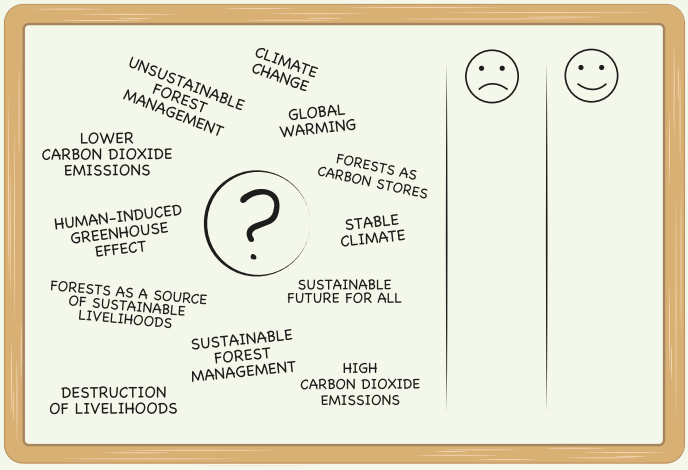


Figure 8.1. Forest concepts

- Next to the Figure on the board, make two columns. Label one column with a happy face and the other with a sad face (see the two smiles in Figure 8.1).

1 Activity 1: Discuss and connect the greenhouse effect, climate change and forests

This activity should take **30 minutes**.

1. Remind the pupils of their homework assignment (from the previous chapter), which was to answer three questions about forests and climate.
2. Invite a few pupils to share their answers. Complement the pupils' answers if some important concepts are missing.

   ► What is the human-induced greenhouse effect?

   » **Answer:** The human-induced greenhouse effect is mostly the result of our dependence on fossil fuels for energy and their high emissions of harmful greenhouse gases.

   Explain: Large amounts of carbon dioxide are released when we burn coal, oil and gas for energy. We contribute to the problem whenever we use this energy to drive our cars, cook our food and heat or cool our homes and other buildings. Air travel and the manufacture and transport of goods also cause greenhouse gas emissions when they involve the use of fossil fuels. Clearing and burning forests release carbon dioxide and other greenhouse gases. The raising of livestock such as cattle and pigs causes the emission of methane, which is a potent greenhouse gas.

   ► How is the human-induced greenhouse effect related to climate change?

   » **Answer:** The higher the concentration of carbon dioxide, methane and other greenhouse gases in the atmosphere, the more heat is trapped close to the Earth, increasing the temperature. This increased greenhouse effect is responsible for global warming and climate change.

   ► How can forests help combat climate change?

   » **Answer:** Trees can reduce climate change by absorbing carbon dioxide and storing the carbon in wood.

   Explain:

   » When trees are cut down to make wood products like furniture and timber for construction, the carbon stays locked inside these products, potentially for hundreds of years. Increasing the use of wood in construction and in products such as furniture, floors, doors and window frames can help reduce greenhouse gas emissions. For example, it is better to use wood instead of less climate-friendly materials such as concrete, metal, bricks and plastics, the production, use and disposal of which emit much larger amounts of greenhouse gases.

   » Forests and trees also influence local weather conditions. The leaves in treetops block the sun's rays and provide shade. Trees absorb water from the soil through their roots and release it into the air through their leaves (transpiration); the water absorbs heat as it transforms from liquid to vapour, cooling the air.

3. Tell the pupils that our actions can lead to one of two paths regarding forests and the climate: a positive path, or a negative path.
4. After the review, organize the pupils into groups of eight to ten.

5. Point to the terms written on the board and explain that each group will:
   a. Discuss whether each term on the board belongs to the positive path or the negative path.
   b. Arrange the terms in logical order, one under the other, linked by arrows. The two columns represent the positive and negative paths.
6. Ask the pupils to make two columns on a page in their exercise books, one headed by a happy face and the other by a sad face. They will write each term in a logical sequence in one of the two columns.
7. Start the ball rolling by writing "unsustainable forest management" at the top of the column with the sad face and "sustainable forest management" at the top of the column with the happy face.
8. Draw a downward-pointing arrow under each (see Figure 8.2).
9. After 15 minutes or so, discuss the results with the class.
10. Ask one group to name the next term below "unsustainable forest management". If this is incorrect, ask another group, and so on. Give the correct answer if necessary.
11. Continue in this way for both columns, enabling each group to participate equally. Use Figure 8.2 as a guide for the correct order of terms.
12. When the last term has been placed in the correct column, ask the pupils to make any necessary corrections in their exercise books.

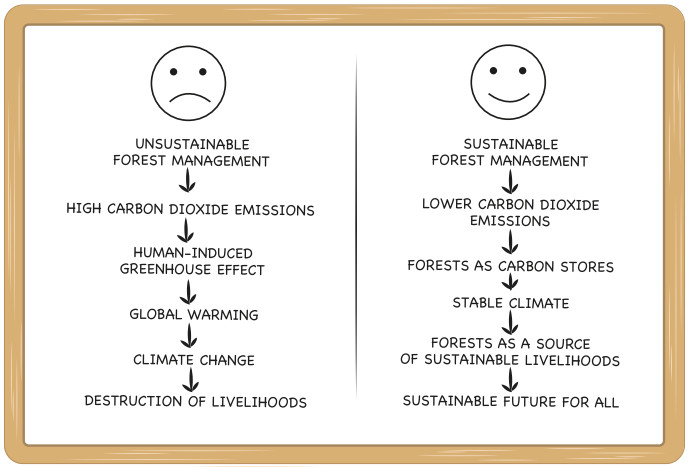


Figure 8.2. Sustainable versus unsustainable forest management

2 Activity 2: Brainstorm on what we can do for forest conservation

indoor This activity should take **10 minutes**.

1. Write the following sentence on the board:

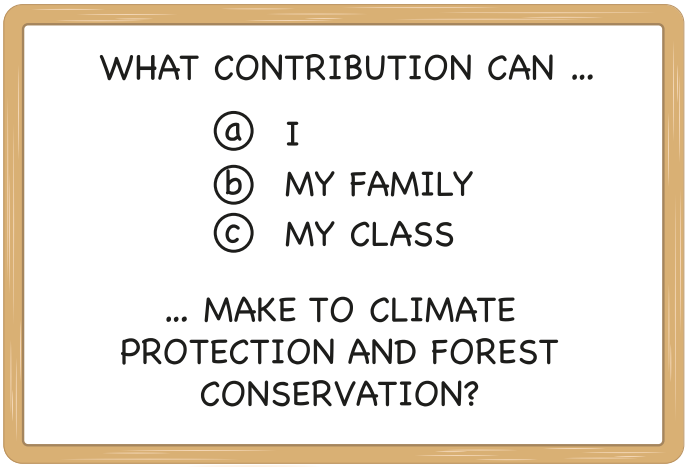


Figure 8.3. What contribution we can make

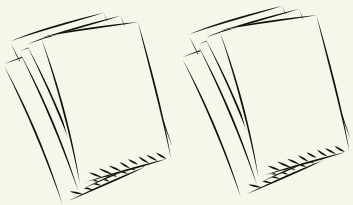
2. Organize the class into eight to ten groups.
3. Ask the groups to create a list of things that they, their families and their class can do to conserve forests as a way of fighting climate change. Examples:
   - I could plant trees to capture carbon dioxide and make my surroundings cooler.
   - My class could invite a forester to school to learn more about their work and ask advice on what to do to use forests sustainably.
   - My family could use forest products that come from sustainable sources.
   - My class could create and distribute posters or flyers to inform our community about the forest laws in the United Republic of Tanzania and suggest that people "stick to the law!"
   - My class could perform a play about the importance of sustainable forestry.
4. Invite a few pupils to tell the class about the ideas that their groups came up with. Write these on the board.
5. Ask the pupils to write the ideas in their exercise books.

LESSON 25

Prepare a play or a poster about forests and climate

25

Required materials



5–10 LARGE SHEETS OF PAPER
(e.g. flipchart paper)

OPTIONAL: COLOURED PENCILS, WAX CRAYONS OR OTHERS
(enough for 5–10 groups)

! **Note:** Half the groups will create posters and the other half will create and perform short pieces of theatre.

Preparation for the lesson

1. Make two columns on the board. Label one column as "Poster groups" and the other as "Theatre groups". List the following instructions under each column.
   - **Poster groups**
     - » Remember what you have learned about forests and climate.
     - » Decide together on your poster content.
     - » Agree on the poster design.
     - » Get to work!
   - **Theatre groups**
     - » Remember what you have learned about forests and climate.
     - » Decide together on the content of your scene.
     - » Decide who will act and the roles that they will play.
     - » Practise your short theatre scene.

1 Activity 1: Create a poster or a miniplay on the importance of forests for climate

This activity should take **40 minutes**.

1. The pupils will work in the same groups as in the last lesson.
2. Assign half the groups to creating posters and the other half to preparing theatre scenes.
3. Give each poster group a large sheet of paper to create their poster.
4. Explain the tasks as follows:

Poster groups

- The pupils will work in their groups to design publicity posters for informing other young people about the importance of forests for the climate and the need to protect forests. Each group will design one poster.
- The pupils will review the content of the last lesson and recall what they learned about the importance of forests for the climate. If necessary, they will consult the notes that they made in their exercise books.
- The pupils in each group must agree on the content and design of their poster.

Theatre groups

- The pupils will work together in their groups to create short theatre scenes to inform other young people about the importance of forests for climate and the need to protect forests. Each group will create one scene.
- The theatre scenes must be no longer than 4 minutes each.
- The pupils will review the content of the last lesson and recall what they learned about the importance of forests for the climate. If necessary, they will consult the notes that they made in their exercise books.
- The pupils in each group must agree on the content of their scene and the best way to present it.
- The pupils will also agree on the roles and assign them to different members of the group.
- Two to three pupils will be the directors – their role will be to help the other pupils rehearse and perform the scene.

5. Give the pupils time to create their posters and scenes. Tell them that they will present their work to their classmates in the next lesson. Their presentations must be no longer than 4 minutes.

LESSON 26

Perform a play or exhibit a poster about forests and climate

26

1 Activity 1: Explain the importance of forests for climate – poster exhibition

This activity should take **20 minutes**.

1. The poster groups will each make a 4-minute presentation.
2. Ask one pupil in each group to hold up the poster and another to explain its content.
3. The pupils should applaud at the end of each presentation.

2 Activity 2: Convey the importance of forests for climate – theatre performance

This activity should take **20 minutes**.

1. The theatre groups will each perform their scenes.
2. The pupils should applaud at the end of each performance.

Notes

[1] **NASA**. 2022. FAQ: What is the greenhouse effect? In: *Global Climate Change*. Cited 28 March 2022. https://climate.nasa.gov/faq/19/what-is-the-greenhouse-effect

[2] **Ward, R. 2009.** *Tackle climate change. Use wood*. BC Forestry Climate Change Working Group, the California Forestry Association and Wood Works. www.softwoodlumber.org/pdfs/Book_Tackle_Climate_Change_Use_Wood_eVersion.pdf

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Glossary

Act. A law or formal decision made by a parliament or other group of people who make the laws for their country or province.

Atmosphere. The layer of gas enveloping the Earth. It contains a mixture of gases, such as oxygen, carbon dioxide, methane and water vapour. The atmosphere, also called the "air", is held in place by the Earth's gravity.

Bacteria. Microscopic organisms that are among the simplest forms of life.

Bylaw. A regulation set by a local government such as a district or village.

Carbon dioxide. A greenhouse gas that is released into the atmosphere through human activities such as deforestation and burning fossil fuels, as well as by natural processes such as respiration and volcanic eruptions. Too much carbon dioxide and other greenhouse gases is warming the planet and causing climate change. Carbon dioxide can be written as CO_2.

Chlorophyll. A pigment that makes leaves green and is essential for producing glucose during photosynthesis.

Chloroplast. Tiny capsules in the cells of plants and certain algae, which are the site of photosynthesis.

Climate change. A change in the Earth's climate. The world is warming up because of increasing levels of carbon dioxide and other greenhouse gases in the atmosphere. The main concern is that an increase in the Earth's temperature, and other associated climatic changes, will have serious impacts on the environment, affect our ability to grow crops, reduce water availability and threaten ecosystems and habitats.

Climate. The average pattern of weather conditions such as temperature, humidity and rainfall, as measured over a long period, usually at least 30 years. Climate is different to weather, which changes daily.

Forest reserve. Forests in the United Republic of Tanzania protected by law.

Fossil fuel. The remains or traces of plants and animals that lived millions of years ago. Most fossils are found in parts of the Earth that were once under water. The fossils were mostly formed from the hardest parts of living creatures, such as their shells and bones.

Forest fragmentation. The breaking of large areas of forest into smaller patches separated by non-forest lands, roads and other non-forest development. As forests become more fragmented, their ability to perform all their functions diminishes.

Global warming. An increase in the Earth's average temperature over time.

Glucose. A form of sugar produced by plants through photosynthesis.

Greenhouse gas. A gas in the atmosphere that traps heat, thereby warming the Earth. Carbon dioxide is a greenhouse gas, and so are methane and several other gases.

Greenhouse. A glass structure in which plants are grown. A greenhouse creates an artificial environment by controlling temperature, light, humidity, air quality, soil moisture and heat. Its purpose is to grow plants quickly, even in cold weather, by trapping heat from the sun.

Hydroelectricity power station. A facility that produces electricity from the movement of water, usually flowing from a waterfall or a large reservoir, which drives a turbine and generator.

Law. The discipline and profession concerned with the customs, practices and rules of conduct of a community that are recognized as binding by the community.

Phloem. Bundles of cells that, joined end to end, form hollow tubes through which glucose (and the liquid in which it is transported) flows to all parts of a plant.

Pigment. A substance that gives plants (and animals) their colour.

Plant residues. Crop materials such as stems, leaves and roots left in the field after harvest or materials left after a crop has been processed.

Regulation. A rule or directive made and maintained by a government authority.

Solar panel. A device used to convert the sun's rays into electricity.

Sustainability. Meeting the needs of the present without compromising the ability of future generations to meet their own needs.

Transpiration. The process by which plants, including trees, take up water through their roots and release it into the air through their leaves in the form of vapour.

Vapour. A substance, usually water, released into the air as a gas.

Vascular plant. A plant that uses xylem and phloem for transporting food and water to different areas of the plant.

Watershed. A land area that channels rainfall and snowmelt to creeks and streams and eventually to a single river.

Weather. The set of day-to-day conditions in the atmosphere, such as precipitation, temperature and wind. It can change daily and is influenced by the sun.

Wind turbine. A rotating machine that transfers kinetic energy from the wind into mechanical and then electrical energy.

Xylem. Bundles of mostly dead cells, which joined end to end, form hollow tubes through which water and nutrients move from the roots to all parts of a plant.

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